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The Fish Industry.

PASSING UNDER review the various branches of industry, it would seem to be often the case that the older ones are the more backward and show less inclination to adapt themselves to changing conditions and the general growth of knowledge; more often than not, the first are last and the last are first. There are, of course, exceptions, but the fish industry—with which the following notes are more particularly concerned—is not one of these.

We do not propose to recount history or to explore for reasons; our business lies with what is and what might be. Sufficient to exclaim with astonishment that the greatest fishing country in the world is flooded with canned fish from Norway, America, France, and Portugal—to the tune of about £7,000,000 worth a year; that, apart from fresh fish, the consumption of the despised cured, smoked, or otherwise treated products is not a tenth part of what it might be; that the industry as a whole has not advanced in method or mechanism beyond its pre-war state; that we are only just beginning to wake up to a realisation of opportunities neglected and competitors ignored; and that we are hardly yet alive to the possibilities of building up a huge, many-sided industry on the foundations of an abundant raw material and with the "bricks and mortar" of present-day science and engineering.

Neglected Opportunities.

In other words, here we have at our doors abundant supplies of a widely varied and potentially valuable raw material (fish), the bulk of which has hitherto been consumed direct or exported in a crudely preserved state, but which can be put through many kinds of processes to yield an endless series of products—canned, cured, pickled, smoked, and so on—appealing to and, in fact, stimulating the infinity of fancies and tastes of the consumer, and turning to profit *every part* of the raw material, without waste or refuse of any kind whatsoever. In the Chicago packing-house there is no waste, and what has been done for the pig can be done for the herring—or for any other fish.

Herring versus Pig.

We are certainly not getting the most out of fish. It is being wastefully used in a crude and unscientific manner. It is a rich, natural foodstuff whose latent values are not being fully realised. In its present state the industry is in a primitive condition. There is not the slightest reason—apart from apathy—why the fish industry should not be as big, prosperous, vigorous, and scientific as its counterpart the meat packing business. If cattle, sheep, and pigs can enter at the factory back door and leave by the front door as canned meat, sausage, pork pies, and the rest, what is there to prevent fish joining in the procession? We have puzzled our brains for a reason, but there has been no response. Why not a fish packing industry, with centralised factories fed direct from the boat, using everything—wasting nothing—and turning out a variety of products which would be the envy of the most hardened pork packer?

Significant Figures.

Take some significant figures. In 1928 the value of British caught fish landed in the U.K. was £18,400,000. In U.S.A. the 1929 catch amounted to £23,200,000—but the 1929 production of canned fishery products was valued at £20,200,000 and the by-products at £4,700,000, giving a total value greater than the original catch. Compare this with the U.K. relationship; we have no figures of the home production of canned fish, but it may be taken to be relatively insignificant. In 1928 we actually imported canned fish to the value of £7,400,000—

although our catch is little short of that of U.S.A., the latter country alone supplying us with 5,466,000 lbs. of sardines and 30,816,000 lbs. of canned salmon. We also imported cured fish to the value of £1,193,000. Last year we took practically the whole of Norway's exports of smoked brisling in tomato and altogether about one-quarter of the total exports of canned fish; from that country we received 222 tons of *kippers*, representing an increase of 60 tons over the 1929 figure and the largest quantity of kippers we have ever received from Norway. But why kippers —above all things?—especially as at last year's Canning Conference at Lowestoft Mr. Wilkinson stated that 70 per cent. of British herrings are exported and asked why they are not more popular at home. The truth of the matter is that we have done practically nothing either to build up an industry on a scale commensurate with the available raw material and the potential markets, or to promote publicity and stimulate buyers. How many people know that fish are rich in vitamins A and D, iodine, and calcium? Evidently not many, judging by the health articles in the daily Press. Even the waste from shrimp factories has been shown (Vilbrandt and Abernethy, *J. Amer. Chem. Soc.*, 1931, p. 633) to contain seventeen parts of iodine per million, to be rich in vitamins, and to constitute an excellent cattle food.

British Research.

It cannot be disputed that British fishery officers and others connected with biological stations, universities, etc., have contributed more than those of any other nation to the study of the habits, movements, and, in general, the natural history of the fish off our coasts. The statistical side of their activities is also admirable. But there it ends—more or less. Once the fish is landed, the gentleman with the white collar raises his hat and says good-bye; after that nobody seems to care whether it is turned into a sausage or is thrown back into the sea. It must, however, be admitted that there are signs of a revision of this attitude and that something is being done, or going to be done. Thus problems coming under the head of handling and storage have been tackled by the Food Investigation Board, and certainly the limited work has been done thoroughly, and will undoubtedly be found to be one of the most potent factors determining the readjustment of this side of the industry in accordance with modern requirements and knowledge. For more information on this subject the reader is referred to Mr. Lumley's article on another page, where a description of the activities of the recently established Torry Research Station at Aberdeen will be found.

British Methods.

There is no doubt whatever that the work of the Torry Station will be comparable with that at the Cambridge Station in its accuracy and thoroughness; it will start at the bottom, digging into fundamentals, and then proceed to build up (slowly and with the characteristically British "step-by-step" method) a structure of exact and unassailable knowledge. That is how it should be done, but the unfortunate thing is that it takes *time*, and, particularly, a very long time before the full fructification period is reached. Meanwhile, the industry languishes for want of a stimulant. This should be supplied by the research workers; if it comes from other sources there is danger of costly experiments and failures. The alternative is to speed up research: for that money is required, and the proper source is the industry itself. But if the industry is poor, then we naturally turn to the State for assistance. Between the two, funds should be forthcoming sufficient to provide the men and equipment necessary for a "big push" in research—which is the only way of signifying the urgent requirement of to-day. That this is not an impossible demand can best be demonstrated by a brief survey of what has been and is being achieved in other countries—although comparisons of this nature are not generally considered "good form."

Fish Research in U.S.A.

In the United States research on fishery products is active and well organised, and, what is equally important, is supplemented by efficient means for broadcasting its results, as well as information relating to practical difficulties arising out of processing and marketing.

First and foremost, there is the Bureau of Fisheries, part of the U.S. Department of Commerce, Washington, D.C. Then, also, there are the College of Fisheries at the University of Washington, and the North-West Branch of the National Canners' Association, both at Seattle. Since the war the Bureau of Fisheries and the College of Fisheries, in particular, have considerably intensified their research activities. Laboratories have been instituted with special reference to the problems of the fish products industries, and the results of experiments conducted in these and other laboratories—many of which are recent additions to manufacturing concerns—have been applied to works practice, with the result that, as stated in the Report of the Commissioner of Fisheries for 1930, "the industry forged ahead in a revolutionary fashion."

The Division of Fisheries.

This particular branch of the Bureau of Fisheries (U.S. Department of Commerce) is concerned with the activities and welfare of the various fishery industries. Its functions are the collection and publication of fishery statistics, the prosecution of research designed to solve the technical problems of

the industry, and the dissemination of sound, practical information to the fishery industries and the public.

It issues "Memoranda," which take the form of typed notes of two or three pages, giving technical information on various aspects of fish processing. Up to the end of 1929, some 315 of these had been compiled for circulation. In addition it publishes an Annual Report containing fishery statistics of the United States and a summary of the activities of the Division. Two publications are particularly worthy of note—namely, Harden F. Taylor's "Documents," Nos. 884 and 919, on the salting of fish.

Remarkable Progress.

The above-mentioned report gives the following particulars of the achievements of science in the fishery industry. Excessive overhead expense in the production and manufacture of fishery products has been reduced; a larger number of inland consumers have been supplied with fresh and frozen fishery products, especially those marketed in attractive unit packages of uniform quality; by-products, which formerly were utilised for fertilisers or in the arts and industries, are now used for foodstuffs and, in addition, the rôle of fishery products in the dietary of man has been demonstrated; waste products of the fisheries have been converted into valuable articles of commerce; better methods have been evolved for the manufacture of certain cured and canned fishery products; and preservatives have been developed which prolong the life of fishing nets. All this has stabilised the fishery industries, and the strides made have been so rapid that certain other food industries are looking toward them for guidance, especially those manufacturing frozen food products.

Work in 1930.

During the past year the Division's technologists have been conducting research mainly on problems relating to the manufacture of fish meal and oil, the feeding value of marine products, the handling and transportation of fresh and frozen fish, and the preservation of nets. These problems have carried the technologists to many parts of the country where conditions are studied first hand. The Reedville laboratory was kept open all the year, due to the fact that problems in the menhaden industry were involved and required continuous study. In addition, a summer laboratory was established at Erie, Pa., to study net preservatives, and a temporary laboratory was in operation at Columbia, S.C., to study the precooling of fish in the South. During the school year the bureau had an employé at Johns Hopkins University, studying the nutritive value of fishery products in co-operation with the nutritional authorities there.

Germany.

It is only to be expected that this scientifically minded country would make adequate provision for research applied to the fishery industries. Such is, in fact, the case. At Wesermünde, on the Baltic coast, is the Institut für Seefischerei, under the directorship of Dr. Fr. Lücke. Since 1925 the Institute has issued a monthly publication recording the results of researches and other matters of interest. In 1928 the Institute was housed in a commodious and well-equipped building, comprising chemical, physiological, biological, physical-chemical, and bacteriological laboratories, library, photographic room, and a spacious, well-lighted, experimental department, measuring 80 by 30 ft., in which work on a semi-factory scale in salting, pickling, smoking, retorting, etc., is carried out. Adjacent are smaller rooms for special purposes, and one of these is fitted with a semi-automatic closing machine, and also apparatus for testing canned goods. The entire equipment was presented by the local industries.

Not only does the Institute busy itself with research and routine analyses, but it also carries on propaganda work designed to bring before the public information relating to the nutritional value of fish products, together with popular expositions of the various phases of the fishery industry. This is done by means of lectures, films, Press articles, and so on. Still another activity is concerned with the provision of facilities for study and practical courses, in co-operation with various universities, schools, etc. (See photographs on page 108.)

German Researches.

The work of Dr. Lücke and his colleagues—among whom may be mentioned Drs. Struve, Runge, Moll, Bähr, Otto Wille, and Walbrath—has been extraordinarily thorough and comprehensive. The results have been published from time to time, chiefly in *Die Fischwirtschaft*, and the subjects embrace testing of raw materials, salting, pickling, smoking, drying, freezing, canning, fish meal and oil, the treatment of refuse, the preparation of caviar, marinated fish and other special products, the handling of fish, the food value of fish, and so on. In addition, several special reports have been issued, such as "*Ein neues Konservierungsverfahren für Fischgeleewaren*," by Dr. K. Struve (1929); "*Zur Kenntnis der Salzheringsvertranung und ihrer Verhütung*," by Dr. Otto Bähr and Otto Wille (1930); "*Zur Kenntnis der Garnele und Garnelenerzeugnisse alse Nahrungs- und Futtermittel*," by Otto Wille (1930); "*Beiträge zur Geschichte des bremischen Heringshandels*," by Dr. Ernst Runge (1930); and "*Beitrag zur Kenntnis und Bekämpfung der Erreger der Geleekrankheit*," by Dr. Th. Moll (1929).

The activity of the laboratories and the rapid growth of the Institute as a whole may be gauged

from the fact that during the period 1926-27 the number of analyses carried out was 3,497, whilst those of the previous were as follows: 1922-23, 182; 1923-24, 632; 1924-25, 2,363; 1925-26, 2,801. Since the rebuilding and extension of the premises in 1928, there has been a considerable increase in the amount of testing, analytical, and other work.

Further Contributions.

One must not forget the "Spezial-Laboratorium für die Konserven-Industrie," of Dr. W. Rossée and Dr. F. v. Morgenstern, situated at New Brunswick, Prussia. This is also the laboratory of the Association of German Candy and Chocolate Manufacturers, and is the source of much of the material published weekly in the *Konserven-Zeitung*. Nor must one omit to mention the publications of Eduard Jacobsen, Otto Sievers, Wilhelm Dunker, and Robert Dudzius on the preparation of fishery products. Finally, there is a useful record of tests and experiments contained in the *Jahresberichte*, 1921-23, compiled by Dr. H. Serger.

Norwegian Research.

Almost completed is the erection of the Research Laboratory of the Norwegian Canning Industry (Hermetikkindustriens Laboratorium), and experimental work has already been started. A photograph of the building is given on page 108. The laboratory is situated at Stavanger, and its particular function is to conduct scentific experiments and tests for the advancement of the fish canning industry. The director is Dr. Gulbrand Lunde, whose papers on the iodine content of fish are well known.

The laboratory consists of three departments—chemical, bacteriological, and processing. The last-named is well equipped with canning machinery, including closing machines, retorts, control instruments, and so on. There are also a workshop, two constant temperature rooms, two refrigerator rooms, a drawing office, various store rooms, etc. The bacteriological department comprises rooms for microscopy, incubator work, and sterilising work; also, several rooms for biological work and a lecture room. The chemical section consists of four laboratories, as well as several rooms for specialised work, such as physical-chemical, optical, electrochemical, and photographic.

Another Norwegian scientist, who has contributed to our knowledge of the vitamin content of kippered herrings, is Dr. Schmidt-Nielsen; he is a professor at the Technical Institute at Trondhjem.

Canadian Sardine Canning.

The sardine canning industry is confined almost entirely to the province of New Brunswick. The name of sardine as applied to the Canadian fish is not the true one, as the fish used in the canneries of New Brunswick are the young of the herring. The Maine, U.S., factories, about fifty in number, depend almost entirely on the supplies of fish obtained from Canadian waters. The imports of sardines in 1928 were valued at $677,403 and came principally from Norway. Exports to the value of $536,833 were reported in 1928, principally to British dominions and dependencies. The season for taking this fish extends from April 1 to December 31.

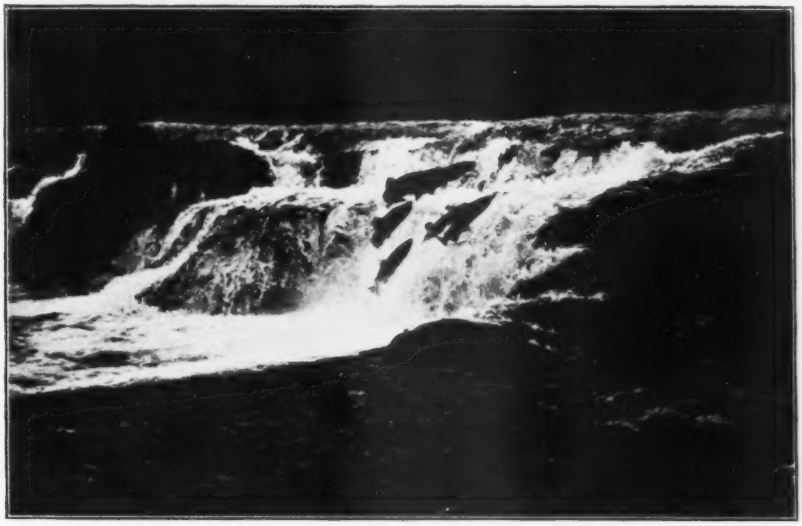
Canada.

In Canada there are two experimental stations for the fishery industry; one, the Atlantic Station, is at Halifax, Nova Scotia, and the other, the Pacific Station, is at Prince Rupert, British Columbia. An examination of the reports of investigations convinces one that a great deal of useful work has been and is being accomplished. This research represents one of the activities of the Fisheries Branch of the Department of Marine and Fisheries, Ottawa; another is intelligence service and publicity—for example, the Department issues a monthly *Fisheries News Bulletin*. From time to time conferences are held, and are attended by fisheries supervisors, inspectors, investigators and other officers, as well as by members of the industry itself.

Amongst the reports which have been published by the Fisheries Branch may be mentioned *The Proper Handling of Fish* (Bull. No. 4, 1921); *The Red Discoloration of Cured Codfish*, by Harrison and Kennedy (Rept. No. 11, 1922); *The Discoloration, Smut, or Blackening of Canned Lobster*, by Harrison and Hood (Rept. No. 12, 1923); *The Bacteriology of Certain Sea Fish*, by Harrison, Perry, and Smith (Rept. No. 19, 1926); *The Preparation of Lobster Paste*, by Ross (Bull. No. 10, 1927); *Historical Account of the Lobster Canning Industry*, by R. H. Williams (1930). The work of Dr. Harrison and his colleagues emanates from the bacteriological laboratories of Macdonald College. Two publications by E. Hess, one, *The Bactericidal Action of Smoke (as Used in the Smoke-Curing of Fish)*, (1929), and the other, *The Amount of "Dry Meat" in Canned Lobster in Relation to Exhausting and to the Age of the Can* (1929), are products of the Halifax Experimental Station.

Note should be made here of a report just published by the Fisheries Department of British Columbia, entitled, *Fish Meal: Its Composition and Value, with Instructions for its Use in Feeding Cattle, Swine, Sheep, and Poultry*.

It was our intention to summarise the work carried out in 1929 at the Halifax and Prince Rupert Stations, but owing to lack of space this is held over till the next issue.



Salmon Headed Up-river towards the Spawning Ground.

Salmon Canning

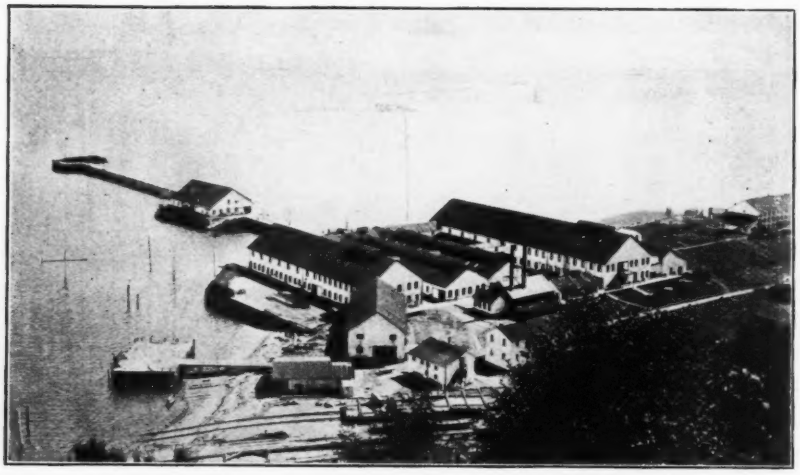
By JOHN N. COBB,

Late Dean, College of Fisheries, University of Washington; Author, "Pacific Salmon Fisheries," "Canning of Fishery Products," etc.

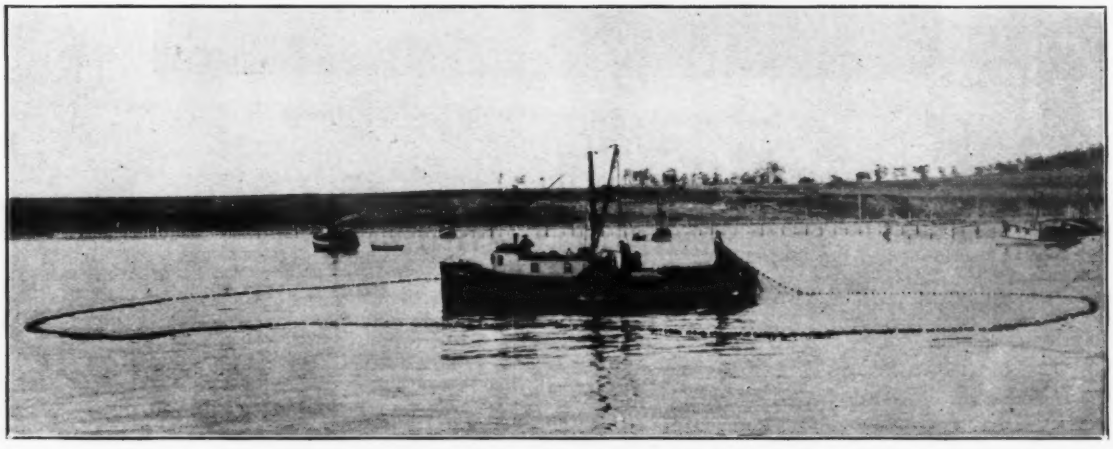
The following is a brief outline of the American Pacific Coast salmon canning operations.

FROM VERY early times certain of the Pacific Coast canners looked forward to the day when machinery would largely replace man, the food product being carried through all the processes of manufacture from the live animal to the sealed receptacle without being touched by hand. In recent years at a number of the more modern plants this ideal has been realised through power brailers, which dip the salmon from the great traps or enclosures in which the majority of them are caught, and retained alive until needed, and dump them, kicking and tumbling around, into monster scows divided into compartments, some of these scows holding 60,000 to 80,000 fish; these are then towed to the canneries and moored alongside elevators, into the lower part of which the salmon are allowed to flow automatically through doors in the sides of the scows, and then raised to the upper cannery floor, whence they pass through chutes to that wonderful machine, the "Iron Chink." This machine cuts off the head and tail, splits the body along the belly, brushes out the entrails, cuts off the various fins, removes the slime and dirt from the outside and the blood from the inside, and delivers the body cleaned and cooled, through immersion in icy water, to the cutter, which cuts it into pieces to fit the desired size of can, either one-pound tall, one-pound flat, or half-pound flat. Another machine then takes the pieces, and with a plunger drives them into the tin cans which are coming down from the loft in a continuous stream, each with its one-fourth ounce of pure salt for flavour. The cans come from this machine in a steady stream, at the rate of about 125 per minute, and pass on an endless belt to and through the weighing machine. Here, if a can does not record the correct weight, it is automatically shunted to one side, where enough is added to bring it up to the weight marked on the label.

Next, the can passes to the topper, where the sanitary top is put on loosely, after which heavy jets of water are discharged against the sides, the first of the many devices for cleaning the outside of the can. The cans then enter the exhaust box, where they are heated while passing backwards and forwards on chain belts by jets of live steam. Recently, machines have been introduced for the purpose of exhausting the air of the can by mechanical means.

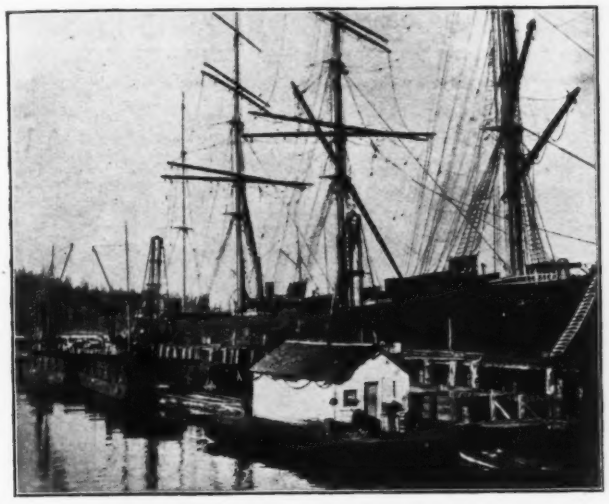


A Puget Sound Salmon Cannery.



Purse Seine Set around a School of Salmon.

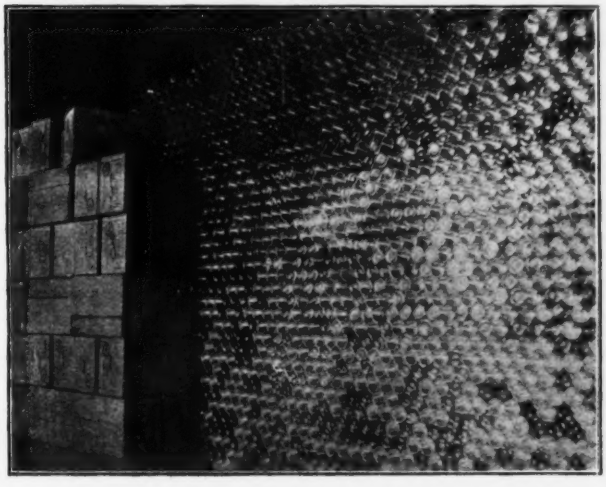
Salmon Delivered alongside the Elevator of the Cannery. Some of these Scows will hold as many as 65,000 Salmon.



Showing Types of Ships, Scows, and Boats at Soring Cannery of the Alaska Packers' Association.

Salmon on the Dressing Floor of the Cannery.

The endless belt then carries the heated cans to the double seamer, where the tops are tightly crimped or sealed on, and then carried through a washing machine lined with stiff brushes and filled with hot lye water, in which the outsides of the cans are thoroughly cleansed as they move in endless procession.



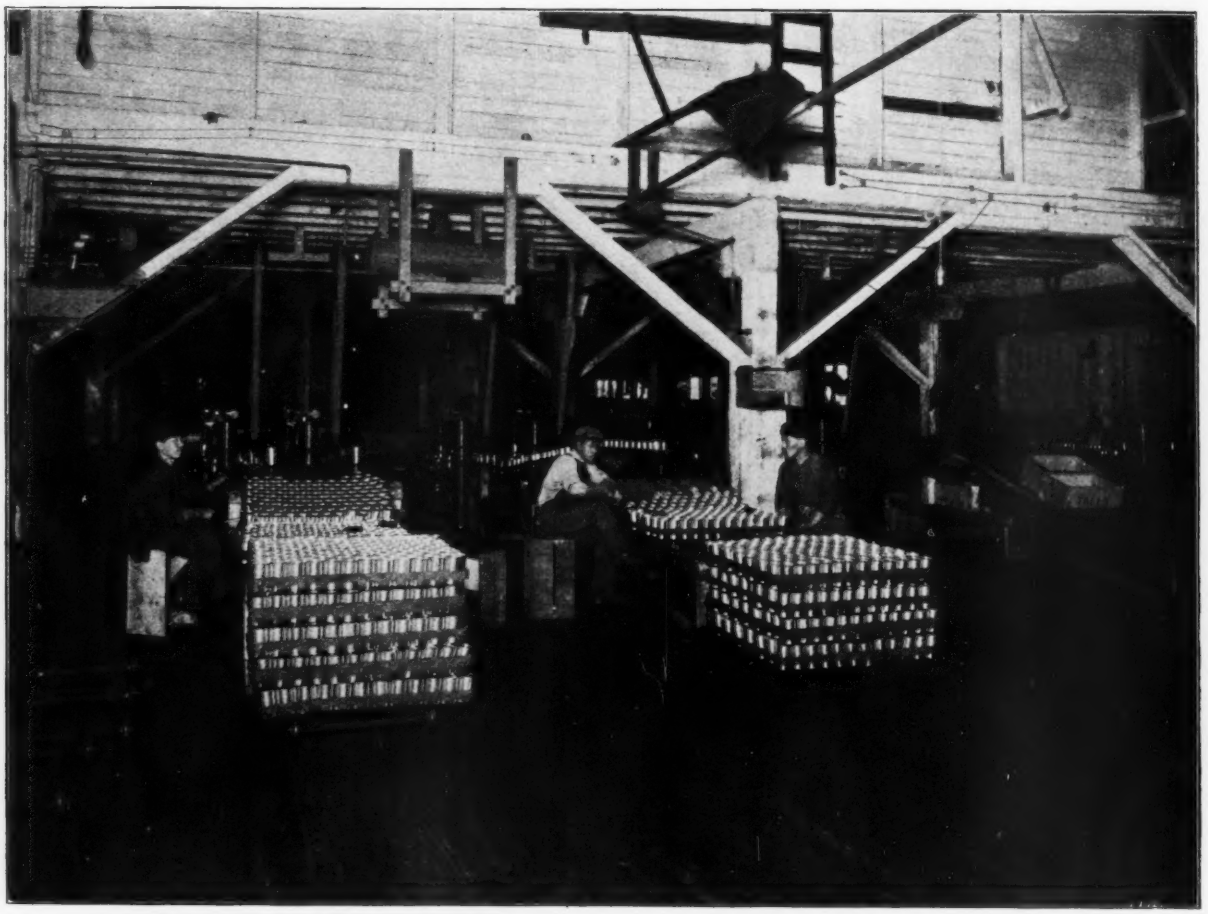
Empty Cans piled ready for Use. Millions are required for each Season.

A few yards farther and they are at the end of what is called the "salmon line," and are transferred to square containers of strap iron, with two-inch interstices, called "coolers," set upon a small car. A cooler will hold 143 one-pound tall cans set on end. As soon as one cooler is filled another is set upon it, and so on until the car load is obtained, which in the case of one-pound talls would be 858 cans, when the car is run along a track to the bath-house, a large section with a row of immense steel retorts set along each side. Small turntables facilitate the transfer from the main track to the branch running into the

A King Salmon.

A Portion of one of the Salmon Cannery Dining Rooms.

Hospital maintained by the Alaska Packers' Association at its Naknek (Alaska) Cannery.



Canned Salmon as they come from the "Line" and before Cooking.

retort. Some retorts will engulf three of these cars and thus will hold 2,574 one-pound tall cans at a time. When filled, the great massive metal door is swung to, or else is lowered in grooves, locked, and then steam is turned on. The filled cans are cooked an average of ninety minutes at a steam pressure of fifteen pounds, which gives a temperature inside of the retort of 250° F.

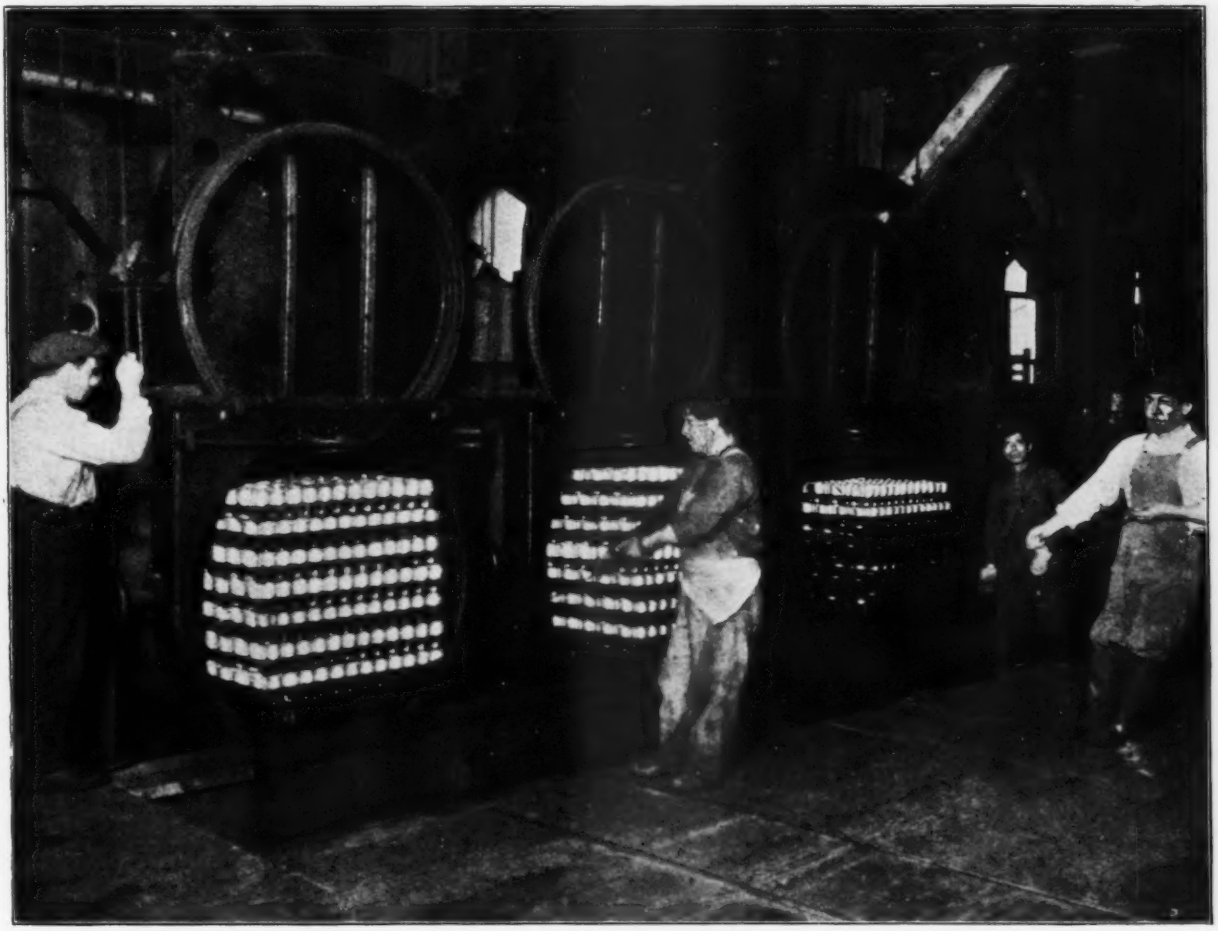
In order to ensure the proper cook in these retorts a control device that is operated by compressed air and automatically regulates the time, pressure, and temperature, is attached to each retort. When the proper time has arrived, the device shuts off the steam and shortly the retort is opened, and the cars pulled out by means of long iron hooks.

The coolers are then placed on endless belts which carry them down into and through a hot lye bath, during which workmen armed with long-handled mops clean the tops of the cans, then up out of the lye bath, and then down into a cooling bath of cold water, after which they are wheeled one by one into an immense warehouse, where they are set on the floor and allowed to cool for several days.

All of the cans at this stage have their ends bulged out as a result of the internal heat, and as they cool to below a certain temperature the ends collapse with a quite noticeable "plop." After the first day or two Chinese, wearing felt slippers, pass back and forth over the cans, and, tapping the tops with a slender strip of metal, pick out and set aside those cans which through leaks or other causes do not give forth the clear resonant sound of a perfect can. As long as these cans are in this warehouse this inspection is carried on at frequent intervals, as sometimes the leak holes are so minute that they take days to show up.

After cooling and inspecting, the cans are stacked in piles, each grade and size in separate piles. This is not done solely for the purpose of distinguishing one grade from another, as every up-to-date canner has a private mark on each can showing the date packed and the grade of fish in the can, but for convenience in lacquering, labelling, and casing.

Later, they are lacquered in machines, although many canners now lacquer only the ends and cover the side with the label. The latter is done for two reasons: (1) Because this method prevents rusting; and (2) as the solvent of the lacquer used is gasolene, the lacquering period is one of extreme danger in the wet, cold climate of Alaska, when doors and windows are generally closed, and numerous disastrous fires have resulted when employés unthinkingly indulged in a surreptitious smoke and thus ignited the accumulated gases.



Cooking the Canned Salmon in Retorts.

The Corrosion of Cans

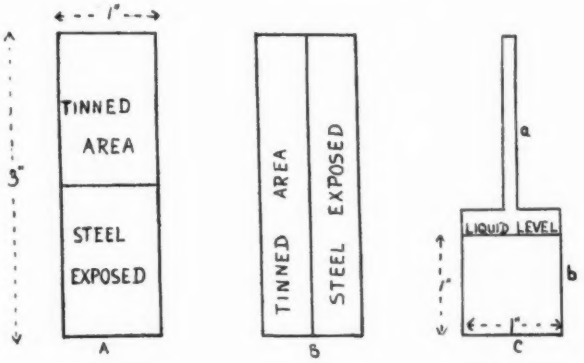
By T. N. MORRIS, M.A., and J. M. BRYAN, B.Sc.,
Low Temperature Research Station, Cambridge.

It is to the credit of Cambridge that two of its scientific workers have recently completed researches which are without doubt the most important yet contributed towards the elucidation of the mechanism of corrosion. The results of these will be of inestimable value to the industry. The following is a brief account of this work.

ONE OF the most important problems with which the canning industry is concerned is that of reducing to a negligible minimum the chances of any reaction occurring between the tinplate of the can and the contained foodstuff. Until quite recently, most of the research work devoted to these so-called corrosion problems has been done in U.S.A., notably by Kohman, Sanborn, and other chemists at the Research Laboratory of the National Canners' Association (see the various bulletins and circulars issued by this Association). Lately, however, the subject has been investigated at the Low Temperature Research Station,* Cambridge, and data of considerable interest have been accumulated. We have studied, in particular, the factors affecting the corrosion of the tinplate container by fruit acids, with special reference to the formation of hydrogen swells and perforations. An outline of the methods used and the principal results obtained are briefly stated below.

Methods.

The aim has been (*a*) to imitate as far as possible the conditions in the interior of a can, (*b*) to study the factors likely to affect corrosion singly or in any desired combination. So far, attention has been concentrated chiefly on the effect of hydrogen-ion concentration in the presence and absence of a limited supply of oxygen and on the action of inhibitors and accelerators of corrosion. In order to arrive at a proper understanding of the problems, these studies have been carried out on mild steel, tin, the tin-iron couple and tinplate. The type of apparatus used is an important consideration. This (see Fig. 2, F.I.B. Report 40) consists of a wide-mouthed bottle fitted with a rubber stopper through which pass two glass capillaries of 1 mm. bore. One of these communicates with a gas burette and levelling tube containing mercury CB; the other has a short rubber tube D attached which can be clipped up during an experiment, but which is necessary for facilitating the removal of gas from the headspace for analysis, for exhausting and for other operations. With such an apparatus we have a closed system in which conditions are similar to those in a can. The headspace may be varied in size and may contain air or an inert gas like nitrogen. Oxygen absorption and hydrogen evolution during corrosion may also be followed and the loss in weight of the strips measured. In the case of tinplate, tin and iron can be estimated in the corroding liquid after a test and the total loss in weight also determined. In the studies on tinplate acceleration of the tests was obtained by grinding off half of the tin from both sides of the plate before immersion, either transversely or longitudinally (see A and B below).



The prepared strips with equal areas of iron and tin exposed to the corroding medium were then suspended from a glass hook or allowed to rest against the side of the bottle. In the case of the tin-iron couple (see C above) projections from the strips of tin or iron were passed through the rubber stoppers and connection made outside. The stoppers were coated with varnish so as to avoid contamination of the liquid by sulphur from the rubber. The tin and iron strips were immersed in the same bottle and the arrangement permitted the connections to be broken and potential measurements taken.

Mild Steel.

In testing samples of the mild steel-base of tinplate in different stages of manufacture it was found that in the samples examined the *cold rolling* process appeared to have the greatest influence in slowing down the rate of corrosion by dilute citric acid (throughout this work 0·5 per cent. citric acid solution was employed as a basal solution to which other substances, the effect of which it was desired to test, were added).

* See Reports of the Food Investigation Board for 1928, 1929, and 1930, also Food Investigation Board Special Report No. 40, by T. N. Morris and J. M. Bryan, published by H.M. Stationery Office.

Armco iron sheet, a pure form of iron, was found to be more resistant than the steel base. Hence the question arises as to how far it may be possible to modify the steel base so as to check corrosion, and it looks as though it might be profitable to study further the effect of the cold rolling.

Curves have been prepared showing the effect of varying the hydrogen-ion concentration of the corroding media in the presence and absence of a limited amount of air. On the whole, these show that oxygen has a much greater effect in increasing the corrosion of iron at low acidity (*p*H 5·5 and 5) than at high acidity (*p*H 2·4). Actually at *p*H 2·4 the effect of oxygen is almost negligible.

A curious effect was noticed with the steel strips which is believed to be of fundamental importance in corrosion. At *p*H 2·4 the corrosion was confined mainly to the edges; at *p*H 5 and 5·5, however, it was confined to the middle region of the strips, leaving the edges unattacked; *p*H 4 was a transitional point. This was noticed both in the presence and absence of air, although less apparent under the latter condition. This seems to us to indicate that at high acidity corrosion is confined chiefly to exposed areas, whereas at low acidity it occurs in more protected areas, and may explain the greater tendency towards pitting and perforation at low acidity. (In varying the *p*H, sodium citrate was used as a buffer; the *total acidities* of the solutions were the same, but the quantity of sodium citrate varied so as to give a *p*H range from 2·4 to 5·5.)

The fact that oxygen is more effective as a corroding agent at low acidity than at high indicates that a good exhaust is especially important at low acidity.

Tin.

Tin is not attacked by non-oxidising organic acids in the absence of oxygen to a measurable extent.

In the presence of air it is attacked most rapidly at high acidity (this is not necessarily the case when it is in contact with iron).

The Tin-Iron Couple and Tinplate.

Allowing for somewhat different conditions, the corrosion of the tin-iron couple and tinplate are similar. Tinplate is to be regarded as a special case of the tin-iron couple in which the tin is present in limited amount, but covers a very large area as compared with the iron. Hence although the couple effect may be somewhat small at first, it will increase very rapidly as the thin tin coating is removed.

The chief properties of the tin-iron couple are as follows:

1. The mere presence of tin in the same solution as iron (without contact) has a great effect in slowing down the corrosion of the latter: this is much more marked when the two metals are in contact. The first effect is undoubtedly due to the inhibiting power of traces of tin salts in solution on the corrosion of iron.

2. Tin is attacked slowly when in contact with iron even in the absence of air. This attack is more marked in the presence of air, and in both cases is greatest at *low acidity* (within the range *p*H 2·4 to *p*H 5·5). The maximum attack on the tin may occur at any *p*H from 4 to 5·5, according to the relative positions of the two metals.

3. The hydrogen replaced from the acid by the dissolution of tin is evolved from the surface of the iron—so that all the hydrogen comes from the iron surface. This is due to the high over-potential of hydrogen on tin. Even in couple no tin would go into solution were it not for the fact that the iron provides an avenue for the escape of hydrogen.

4. American workers (Kohman and Sanborn, and Lueck and Blair) have shown that there is a reversal of potential after immersion of the tin-iron couple in acid solution. Initially the iron is the anode (the corroding metal), but in a very short time the current is reversed and the tin appears to be the anode. This is no doubt connected with the fact that the iron is the only avenue for the escape of the hydrogen. Actually, however, the current is exceedingly small, being too small to measure by means of a sensitive milliameter, and it must not be thought that, because the tin is apparently the anode, it is the only metal which is corroding: the iron may really be corroding at the same time faster than the tin through the action of local couples.

5. It is almost invariably observed that when for any reason the corrosion of the tin member of the couple is diminished, the corrosion of the iron shows a corresponding increase and vice versa.

The fact that tin is attacked most at low acidity (corresponding to that of the less acid fruits), coupled with the fact that fruits of low acidity like cherries, bilberries, blackberries, and dried prunes give most trouble as regards hydrogen swells and perforations, seems significant, and has led us to put forward the theory that in the main the rate of formation of hydrogen swells and perforations depends on the rate at which tin is removed from damaged spots, pin holes, or scratches in the lacquer in the case of lacquered cans, or from large areas in the case of unlacquered cans, thus leaving the iron open to attack.

This view differs fundamentally from that of Kohman, who thinks that tin suffers the greatest attack in couple at high acidity. This seems quite wrong—at any rate within the range found in canned fruits. Kohman based his opinion on determinations of the single potentials of the metals in hydrochloric acid solutions diluted so as to give a *p*H range the most alkaline member of which was *p*H 3. Thus many of his solutions were quite on the acid side of the *p*H range found in fruits. Moreover, the dilution method does not seem very satisfactory, since the total acidity of a hydrochloric acid solution of *p*H 3 is low unless a very large volume is taken. We agree with him that tin alone is attacked most rapidly in the presence of air or oxidising agents at high acidity, but things are quite different and much too complicated to deal with satisfactorily in a short article when tin and iron are in couple.

Inhibitors and Accelerators of Corrosion.

The possibility of accelerators or inhibitors of corrosion having an effect in canning had been neglected; it is a fact, however, that a large number of organic compounds with large molecules, and also

some colloidal substances, are known which inhibit the acid corrosion of iron by slowing down or preventing evolution of hydrogen from kathodic portions of the metal. Some of these substances are very efficient and are used commercially as "restrainers" in pickling baths for the removal of oxide films: they prevent or retard metal from going into solution, but do not interfere with dissolution of the oxide.

Other substances, such as sulphur in the form of sulphur dioxide or hydrogen sulphide, accelerate corrosion in acid solutions.

The chief results in connection with these substances which were obtained at the Low Temperature Research Station are as follows:

(i.) Beet sugar has been found to contain an inhibitor of the acid corrosion of iron. This is present as an impurity in the beet sugar and is not due to the sugar itself, which is only a weak inhibitor. Crude beet sugar contains much more inhibitor than refined.

(ii.) Beet sugar and agar-agar have been shown to have a definite protective action on both the iron and tin of tinplate at all hydrogen-ion concentrations met with in canning, but exactly how far the inhibitor in the beet sugar is responsible for the whole of the protection shown is rather obscured by the fact that sulphur was present in all the beet sugar tested.

(iii.) When ordinary cane sugar is inverted by heating a solution of it with acid, an inhibitor is formed. This inhibitor *decreases* the corrosion of iron, but slightly *increases* that of tin in tinplate. Hence it is quite conceivable that it may do harm in canning on the theory already put forward. The benefits or otherwise of beet sugar and invert sugar have not yet been worked out in practice.

It seems likely that since beet sugar decreases the corrosion of *both the tin and iron* with tinplate strips it should have some effect in diminishing the rate of formation of hydrogen swells and perforations.

An important fact in connection with the action of inhibitors (and of accelerators, as will be seen later) is that their efficiency alters considerably with variation in hydrogen-ion concentration. Generally speaking, they are most efficient at high hydrogen-ion concentration. Thus, gelatin was found to be a very powerful inhibitor at *p*H 2·4, but its inhibiting effect was negligible at *p*H 5·5. This was the most outstanding case tested, but the phenomenon was also seen with tin salts, beet sugar, and even with sucrose itself. This may well be another reason why fruits of low acidity give most trouble.

Other interesting features connected with inhibitors are:

1. They often act when present in very small quantities—*e.g.*, two parts per million of tin as citrate halved the rate of corrosion of iron in a 0·5 per cent. citric acid solution.

2. Although small quantities are effective, after a certain stage is reached the addition of more inhibitor has relatively little effect.

As regards accelerators, interesting results have been obtained in studies of the effect of traces of sulphur as sulphur dioxide or hydrogen sulphide on iron and tinplate. With *iron alone*, a few parts per million of sulphur dioxide was found to accelerate corrosion at *p*H 2·4, but actually retarded it at *p*H 5 and 5·5. At *p*H 4 the effect was negligible.

With sugar present the effect at the acid end was more marked, and at the more alkaline end retardation was again seen.

With *tinplate* in the presence of sulphur dioxide there was a remarkable protection of the tin at the acid end of the series, but a great deal of iron was dissolved. At the least acid end the tin was protected, but to a less extent, and the rate of corrosion of iron was comparatively low. A brown stain of tin sulphide could be seen on the tin, especially at the acid end of the series, and there is little doubt that this forms a protective covering. This is interesting, as it explains the results obtained by American workers on the effect of sulphur sprays on the corrosion of canned fruits. They found that with gooseberries (an acid fruit) there was a good deal of trouble from hydrogen swells when sulphur was present. This can be understood from the fact that the sulphur renders the iron *permanently anodic* to the tin and causes the acceleration of corrosion at high acidity. The tin is highly protected at high acidity by an impermeable film of tin sulphide.

At low acidity this film is slightly less protective, although it still gives a good deal of protection, but at the same time the corrosion of the iron is very much reduced. In fact, at *low acidity* the effect of the sulphur is to lower the corrosion of both metals *as compared with that which occurs in its absence at the same acidity*. Hence it is easy to understand how the addition of sulphur compounds—*e.g.*, sodium thiosulphate—to fruits of low acidity like cherries may be beneficial, as was found by Clough, Shostrom, and Clark in America.

Sulphur as sulphur dioxide or hydrogen sulphide is likely, therefore, to be harmful at high acidity and beneficial at low acidity, and is effective when present in minute quantities (two parts per million of sulphur dioxide has a noticeable effect; eight parts per million approaches the maximum effect). These quantities are well within the limit of sulphur dioxide allowed in foodstuffs, but at the present stage it is necessary to exercise caution in adding sulphur dioxide to fruits with which it has not been tried. Also it seems doubtful whether it is safe to recommend the method to canners who have no means of keeping chemical control over their products.

Practical Canning.

Following from the results with tinplate and from the fact that fruits of *low acidity* give trouble, experiments have been carried out at Cambridge on the addition of acid to fruits of low acidity in order to check the formation of hydrogen swells and perforations. These have given highly satisfactory results.

The addition of acid is effective both with lacquered and plain cans. Usually lacquered cans give more trouble from hydrogen swells and perforations than plain ones, but the latter give more discoloration. There has been a good deal of controversy over this, but researches have demonstrated it to be correct on the whole. Even double lacquered cans give hydrogen swells with certain products.

Attention has also been drawn to the effect of cool storage of cans in checking discoloration.

Lacquer Protection of Fruit and Vegetable Cans

By W. B. ADAM, M.A., A.I.C.

University of Bristol Research Station, Campden, Glos.

A critical examination of the pros and cons of lacquering practice as applied to fruit and vegetable cans.

One Corner of the Campden Research Laboratory, showing Haldane's Gas Absorption Apparatus and pH Apparatus.

THE INCREASING popularity of canned fruit and vegetables throughout all sections of the community indicates that the prejudice which was so long associated with this class of product is now definitely on the wane. Nevertheless, there is still a lingering feeling that there is something mysterious and dangerous about the tin can as a container for food, and something natural and "safe" about the glass bottle. The chief point in favour of the glass bottle is that the contents are visible to the purchaser, and with many people this is counted a greater advantage than the improved flavour which is obtainable in the canned article. The practical advantages attached to cans are that they are easier to handle in the factory, are less fragile, weigh less, and are more economic as regards transport costs. These desirable factors have encouraged the scientific study of the problems connected with canning, and it is a far cry from the original tin canister invented by Peter Durand in 1810 to the modern lacquered open-top hygienic can. The improvement has now reached such a stage that the can is regarded by competent medical authorities as an excellent and suitable container in which to preserve the majority of foodstuffs. Whilst it is very satisfying to feel that the can has been passed A 1 in its medical tests, the fact should not be disguised that, like the rest of us, it has its minor ailments, and the purpose of the present article is to discuss briefly the manner in which its internal members war against each other.

When fruits or vegetables are hermetically sealed in cans and sterilised, they should keep in sound condition indefinitely provided no action takes place between the cans and their contents. It is just here that the ideal is not quite reached, and although vegetables are practically inert, it is difficult to prevent fruits from acting on the metal container. The tinplate itself consists of a sheet of steel covered with a thin layer of pure tin; the quantity of tin varies with the type of plate used, and in "coke" plate, which is the type chiefly employed in the manufacture of cans for foodstuffs, the tin coating amounts to approximately 2 per cent. of the total weight.

This thin coating of tin, which only weighs about 12 to 15 mg. per square inch of surface, is very seldom unbroken by the time the cans are made up. In the first place, it is difficult to coat the original plate with a perfectly uniform surface of tin, and minute scratches, specks of dirt, or "waster spots," may cause a break in the coating. These unsatisfactory plates are sorted out and are not despatched from the tinplate works, but it is impossible to eliminate entirely plates which contain microscopic defects. The exposure of the steel base to the action of the can contents is the principal cause of subsequent trouble from corrosion or discoloration, and the method now used to overcome these difficulties is to protect the tinplate by a layer of lacquer. Several types of lacquers—or "enamels," as they are termed in America—are in use, each type being suited to a particular class of canned food.

Another View of the Campden Laboratory.

FIG. 1.—Perforations in Tinplate Along a Line of Scratched Lacquer.

Fruit Lacquers.

Composition and Application of Lacquer.—Fruit cans are generally protected internally by means of a layer of "gold" lacquer. In this country the lacquer used is prepared from copal gum, a natural exudation from giant resiniferous trees. There are many copals of commerce, but the type used for preparing this class of varnish is hard or fossil copal, which is frequently of very great age. The gum is melted by heat, and prepared oils are stirred in while it is still molten. Subsequently diluents are added, and the varnish is allowed to mature for at least six months at a temperature of 65° F. Before applying the varnish to the tinplate, the latter must be very thoroughly cleaned, as any dirt or greasy patches on the plate will spoil the subsequent lacquer surface. The varnish is spread on to the tinplate by means of rollers, and the plate passes through a continuous automatic stoving oven in which the temperature is

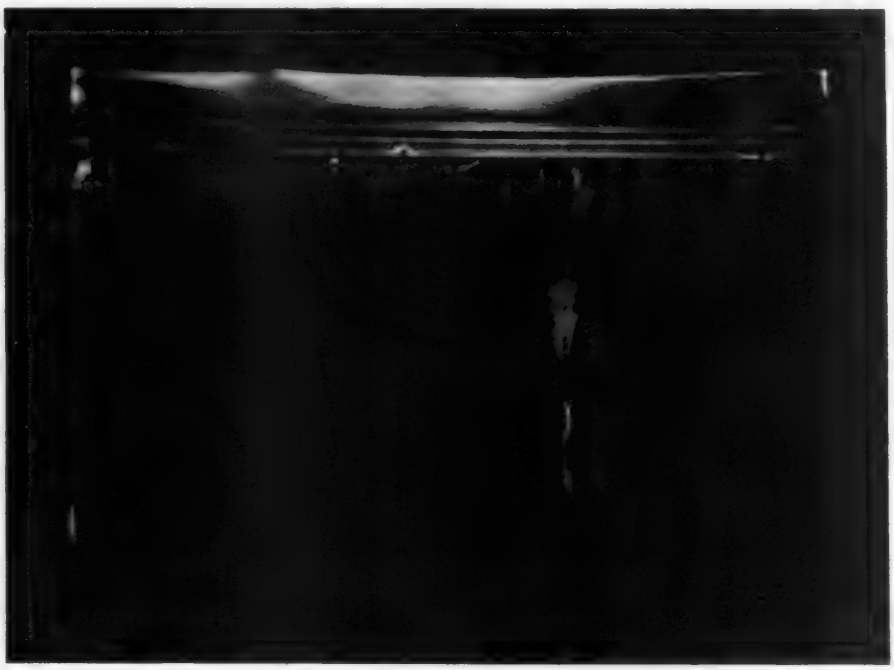


FIG. 2.—Lacquer Scratched and Scorched along the Side Seam; a Perforation is visible on the Seam.

maintained in the region of 400° F. The plate emerges from the oven covered with a very thin but firm coating of lacquer, which generally weighs about 5 to 6 mg. per square inch. It is essential that this coating should be continuous and free from scratches, or the initial object of using a lacquer is defeated (Fig. 1). To ensure that any accidental scratches are covered up, the lacquering is frequently done in two operations, a second coat being applied and the plates again passed through the stoving oven. Too high a temperature causes the lacquer to scorch, and may cause subsequent peeling. At a later stage the lacquer may be burnt when passing through the solder bath if conditions are not properly controlled (Fig. 2), but the operation at which the greatest damage can be done is the stamping out of the ends of the cans. The tinplate is severely distorted not only on the outer groove of the lid, where the double seaming subsequently takes place, but is frequently fractured along the expansion rings if a die has been used which gives too deep an impression. In order to stand up to these severe tooling conditions, the lacquer used must possess a high degree of flexibility. The parts of the can most susceptible to subsequent corrosion are therefore the expansion rings and the seams, but this point will be discussed in greater detail below.

As the lacquer may easily be weakened at any of the points mentioned, and, in addition, scratches may occur during the can-making operations, the suggestion was put forward that spray lacquering of the cans after they had been made up might give a perfect surface. The objection to this procedure is a very practical one, as the space required for stoving the enormous quantity of cans turned out by an automatic line would be very great, and also a satisfactory stoving temperature for the varnish might be too high for the solder in the side seams. Spray lacquered cans were, however, tested very thoroughly in extensive experiments carried out at Campden in 1927, and the resulting products were in all cases excellent.

A very full and clear description of the application of varnish to tinplate is given in a recent book entitled *Tinplate Decoration and Lacquering of Food Containers*, by Mr. A. Ll. Matthison, whose pioneer work on this subject is well known to all interested in food canning.

Reasons for Lacquering.—The purpose of the lacquer is to prevent excessive action of the fruit acids on the tinplate, which may be responsible for several undesirable effects—namely, (*a*) discoloration of the fruit and syrup, (*b*) production of hydrogen swells and perforations, and (*c*) solution of tin in the foodstuff. These three aspects of the corrosion problem will be dealt with separately.

Discoloration due to action of the acid on the metal of the can is almost entirely confined to red and purple fruits, where it takes the form of bluish or purple patches on the fruit or a blue tinge in the syrup. The alterations in colour of strawberries from red to brown, or of gooseberries or greengages from green to a brownish yellow, do not come under the same category. Tests carried out at Campden in 1927 showed very clearly that cans which had received a double coat of lacquer preserved the full natural colour of such fruits as raspberries, loganberries, red currants, black currants, Victoria plums, and damsons for long periods of storage. Fruits packed in single-lacquered cans processed under similar conditions lost colour much more rapidly, and in general appearance were very much inferior to the corresponding product packed in double-lacquered cans. Well-lacquered plate will, however, cause discoloration if the cans have been scratched during or after the can-making process, and great care should therefore be taken to prevent scratching or denting of the cans. Severe corrosion in some cases may lead to gradual bleaching of the natural colouring matters, and another defect arising from the same cause is the cloudiness which sometimes occurs in strawberries and other red fruits when packed in cans which are badly lacquered. This cloudiness may be caused by the presence of minute traces of colloidal tin salts held in suspension in the syrup. From the point of view of appearance, therefore, it is essential that all red and purple fruits should be packed in sound double-lacquered cans.

The second problem to consider is the effect of lacquering on the incidence of hydrogen swells and perforations. These two defects are the result of a series of complicated electro-chemical reactions which take place between the acid fruit juices and the two metals of the tinplate. It is not within the scope of the present article to discuss the nature of these reactions, but they have formed the basis of very extensive researches in America and in this country. It has been shown in America that certain fruits, such as sweet cherries, give less trouble from hydrogen swells when packed in unlacquered than in lacquered cans; if these results are applicable generally, it might therefore be argued that all fruits which are not susceptible to discoloration should be packed in unlacquered cans as a safeguard against loss from hydrogen swells. The fruits packed in England which come into this class are gooseberries, yellow plums, greengages, and white cherries, and of these the first two seldom give serious trouble from perforations or hydrogen swells, and the last only constitutes a relatively small pack. Tests carried out at Campden have not always indicated that the unlacquered can is superior in this respect to the lacquered can, as solid pack apples canned in lacquered cans have withstood storage at 72° F. quite as satisfactorily as corresponding samples packed in plain cans.

Perforations seldom occur on the body of the cans, but almost always at some point where the plate has received a severe mechanical strain. In corrosion tests carried out at Campden, over 90 per cent. of the perforations were found to have occurred either on one of the seams or on an expansion ring. These were spots where the tooling had been sufficiently heavy not only to damage the lacquer surface but also to fracture the tin coating of the plate. Last season the impression on the expansion rings of the cans used was less severe than on the cans of the previous year, and results up to the present show that the incidence of perforations at this spot has been reduced.

An occasional source of trouble from pinholing is through the die-stamping of code numbers on the lids of cans by the canner. This can be successfully done if a smooth, rounded, light impression is used;

but if the stamping is too heavy or sharp, corrosion will occur at this point (see Figs. 3 and 4).

The third aspect to consider is the solution of tin in the foodstuff. Tin is not regarded as a poisonous metal unless it is present in considerable quantities, and cases of illness due to the ingestion of tin salts from canned foods are so rare as to be practically unknown. It should, nevertheless, be the aim of all concerned with the canning industry to pack their products in such a manner that they will be as free as possible from minute traces of metallic contamination. In this respect a sound lacquer coating is of great assistance, as the results of some four or five hundred tin analyses carried out at Campden indicate. Various types of lacquered cans were used in these tests, and it was found that the fruit packed in double-lacquered cans in all cases was much freer from tin than corresponding samples packed in single-lacquered cans. Of two types of lacquer tested, the more elastic gave the best results, presumably on account of its greater flexibility and the consequent capacity to withstand the tooling stresses during can-making. Unlacquered cans gave higher tin figures than lacquered cans. Even after eighteen months' storage the tin content in sound, double-lacquered cans rarely exceeded one-quarter of a grain per pound, which is only one-eighth of the recognised "limit" for tin in foodstuffs.

It will be seen from the foregoing remarks that the points in favour of the lacquered can for fruits are: (*a*) appearance, and in this respect double-lacquered cans are essential for red and purple fruits; and (*b*) relative absence of tin in solution, where lacquering definitely checks the solvent action of the fruit acid on the tin coating of the plate. Against the use of lacquer is the small additional cost involved, and the possibility that in certain cases there may be less trouble experienced from hydrogen swells and perforations if lacquer is not used.

There is one product which must always be canned in very well-lacquered cans—that is rhubarb. The action of rhubarb on tinplate is so severe that even the best lacquer coating leaves something to be desired. Under no circumstances should unlacquered or poorly lacquered cans be used for rhubarb.

FIG. 3.—Outside of Lid, showing Heavily Impressed Code Number.

FIG. 4.—Interior of the same Lid; note the severe Corrosion where Metal and Lacquer Surfaces are Fractured.

Vegetable Lacquers.

The majority of vegetables are of a non-acid character; nevertheless, this does not entirely eliminate the tendency to remove traces of the tin from the plate. Although they do not react on the tinplate in such a manner as to produce hydrogen swells, they manage to give a small amount of trouble in another respect. The high temperatures employed in the sterilisation of vegetables bring about partial decomposition of certain sulphur-containing proteins, with consequent release of traces of volatile sulphur compounds. These compounds form a surface layer of dark sulphides of tin and iron on the inside of the can, and this thin layer may give the appearance of a brown, black, or purplish stain on the tinplate. There is nothing objectionable about this discoloration except that it is displeasing to the æsthetic eye.

(*Continued on page* 120.)

Research and the Fish Industry

An Account of Some Recent Investigations

By the SUPERINTENDENT OF THE TORRY RESEARCH STATION

TO DEAL with the important subject of the storage and transport of food, the Department of Scientific and Industrial Research established the Food Investigation Board, of which Sir William B. Hardy, F.R.S., is director. At Cambridge, in conjunction with Cambridge University, the Low Temperature Research Station was built and has become the scientific headquarters for food investigation. As part of the same general scheme of research, the Department has lately established two other stations —the Ditton Laboratory at East Malling in Kent, for the study of fruit storage and transport, and the Torry Research Station at Torry, Aberdeen, for the investigation of analogous problems connected with fish as a food commodity.

The fish industry was hard hit by the war, and an almost complete dislocation occurred; many of the fishing vessels and their crews were taken into the mine sweeping and patrol services, while those which remained were closely restricted in their fishing operations. The industry has not made a good recovery, and generally, in method and mechanism, it has not advanced beyond its pre-war state.

In contrast with pre-war consumers, present-day consumers of fish in this country have a more particular idea of the quality of freshness, which is only to be expected in view of the increase in the standard of living. The old methods of handling and stowage still rule, and while perfectly fresh fish has a high value—there is seldom enough of it on any coastal market to satisfy the day's demand—unfortunately too much fish is landed of an inferior condition, the value of which has depreciated because the home consumer is tending to ignore it. The position, therefore, is that, aggravated by the impaired purchasing power of those fish consumers who are directly affected by industrial depression, an unremunerative level of fish values is produced at coastal markets, and many of the vessels barely cover their running expenses, while quite a number have been working at a loss.

There is justification for thinking that the industry could take some steps towards improving quality, and, moreover, that to this end Research could be of service. Some work in this direction has already been completed by the Food Investigation Board.

Handling and Stowing of Fish.

In 1928 a series of voyages were made in two steam trawlers to investigate the conditions of handling and stowing the fish on board ship. It was observed that, with the customary methods, the commoner white fish would not last in ice in a fresh condition for longer than seven days. It was found that by altering the present methods and introducing more careful handling and greater cleanliness in stowage, the period of freshness could be extended to twelve days. Beyond this, however, ice was powerless as a medium for preserving the original freshness of the fish.

There is no doubt, however, that a considerable proportion of the fish caught by British trawlers is kept in the hold for periods of from eight to twelve days and, under the existing methods of handling and stowage, loses its quality of freshness before it arrives home for sale.

By employing methods which are fully discussed in the Report issued in 1929 by the Food Investigation Board,* owners whose trawlers make round trips up to fourteen days could, while adhering to ice stowage, save much of this deterioration in quality. This should mean an increased value of their landings, and the industry might immediately profit from the result of this experimental work.

For the vessels making longer voyages, during which the fish would have to be stowed beyond the ascertained ability of the ice to keep it fresh, some method of refrigeration must be adopted, and the subject is under investigation at the Torry Research Station. The problem is to find an economic system of freezing and cold storing during the voyage, and at the same time to avoid the loss of flavour, good texture, and appearance of the fish when it is landed for sale. Obviously it would serve no useful purpose to bring home fish, however well protected from the normal process of decay, if it did not also possess the other characteristics of freshness.

The long-voyage trawler can carry only enough coal to stay away for some five or six weeks, and the period during which the fish would have to be kept in cold store is not a lengthy one from the standpoint of refrigerating practice.

When a fish is frozen and kept in cold storage, the changes which occur in its tissues depend upon the rate of the original freezing and the temperature of the subsequent storage. The ill-effect of these changes on the texture, flavour, and appearance of the fish when it is ultimately thawed out, can be minimised by employing a combination of quick freezing and low temperature storage.

Experiments have been carried out to ascertain the rate of freezing and the temperature of storage most suitable for a period of six weeks' refrigeration. It was found that haddocks, fresh from the sea, quickly frozen in common salt brine at a temperature of $-4°$ F. and subsequently stored in air at $-5°$ F. had at the end of six weeks lost nothing in appearance or palatability.

Fish thus treated ought to find buyers as fresh fish. They should certainly have a value considerably higher than fish which have been stowed in ice for even half the length of time.

These temperatures are unusually low for refriger-

* *The Handling and Stowage of White Fish at Sea* (Food Investigation Board Report No. 37, H.M. Stationery Office).

ating practice in Great Britain, and the experimental results were obtained by using refrigerating plant which would be too expensive to instal and to operate aboard a trawler. However, refrigerating engineers are already considering the practical, commercial questions which now arise, with a view to designing suitable machinery, economical both as to capital outlay and running cost.

Smoking.

Fish smoking is another direction in which re search being done at Torry should prove useful to the industry.

The connection between the demand for smoked fish and the value of some of the main kinds landed at British ports is both direct and considerable. British smoked products, such as finnan haddocks and kippered herrings, are favoured extensively at home and also abroad. Wood smoke gives a rich appearance and a tasty flavour besides acting as a preservative.

Smoke curing has been practised from time immemorial, but it has hitherto received but scant scientific attention. The process, which consists of hanging the fish in a kiln for a time over the smoke of smouldering sawdust or chips—sometimes peat is used—is commendably simple, but has varied and uncertain results. Apart from the nature of the wood used, the good flavour and texture of the cured fish depend on the temperature and humidity of the smoke, both of which factors are greatly influenced by the atmosphere outside the kiln and the state of the weather.

Here, again—the consumer being more particular than formerly—improved quality should mean increased sales of the product. It is possible that with consistently good results in smoking kippers the home consumption of the herring, which at present is such a small proportion of the total catch, might be considerably increased.

At Torry there is an experimental smoking kiln in which research is being directed towards finding out the particular temperatures and humidities which are best for curing the usual kinds of fish, with a view to devising some effective and inexpensive form of control during smoking operations.

Fish Oils.

Another field of research at Torry is into the nature and functions of the oils and fats of different fish. Souring of the body oils appears to play a considerable part in the rapid deterioration of the herring, for example. This work also aims at a better utilisation of liver oils. The medicinal value of cod liver oil is already well known, but the usefulness of the liver oils of other fish is a subject which hitherto has not been much explored.

The rapid deterioration of fish is largely due to bacteria. These particular micro-organisms are being studied in co-operation with the Bacteriological Department of Aberdeen University.

New Fishery Research Stations

Examples of Foreign Progress

Top: Fishery Museum of the Institut für Seefischerei, Wesermünde, Germany. Right: One of the Laboratories of the Institut für Seefischerei. Left: The new Research Laboratory of the Norwegian Canning Industry at Stavanger.

Recent Developments in the Fish Oil and Fish Meal Industries

By H. M. LANGTON, M.A., B.Sc., F.I.C.

A survey of the present position of the plant and processes used for the extraction of oil and manufacture of meal from fish.

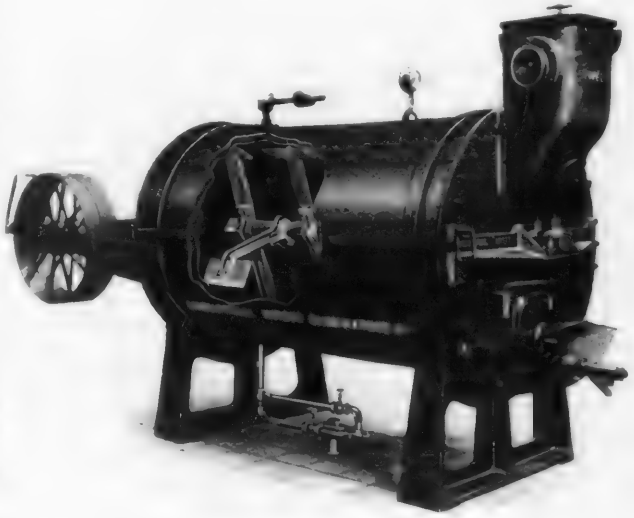
THE OILS from the herring, salmon, sardine, menhaden, and pilchard are produced from the whole fish; in the case of the herring, the oil constitutes 15 to 20 per cent. of the entire fish, whilst in the case of the pilchard the oil may be from 5 to 25 per cent. of the weight of the fish—according to the season of the year. All these oils are closely similar in their chemical and physical properties, and the writer has elsewhere tabulated their average characteristics.* They are of similar chemical composition, and have more or less the same range of applicability in the leather industries, in the manufacture of the cheaper grades of soft soap, in the preparation of insecticide emulsions, and for sulphonation purposes.

A great change has come over the fish oil and fish meal industry in recent years. Every care is now taken to land fish in as fresh a condition as possible, and to treat them before the incipient stages of putrefaction have been reached. As a consequence, not only is a purer oil produced than was formerly the case—an oil of low free fatty acidity and free from albuminous matter and objectionable odour and taste—but the residue which remains after removal of the oil is of such quality that the final stages of its treatment result in a feeding meal of high quality being produced. At one time most of the solid residue was unfit for use as a feeding meal and could only find employment as a fertiliser. It is in connection with the production of fish meal that the industry has witnessed some of the greatest improvements in recent years.

In the most modern factories in U.S.A., Canada, and Japan the fish are landed quite soon after they are caught, and are delivered in bulk by automatic conveyors, whilst still in the fresh condition, into steam digestors or reduction plants, where the fish are partially cooked by steam and then pressed for the removal of the oil. The oil is freed from water in settling tanks, the residue of the fish being passed to a drier, from which, after treatment by dry steam, it emerges as a fine, dry powder usually fit for use as a feeding meal. A considerable industry in pilchard oil and fish meal has grown up in recent years along the Pacific seaboard of U.S.A. and British Columbia. About 1918 it was noted that large shoals of pilchards were visiting the West Coast of Vancouver Island, the fish abounding in the waters thereabouts from June to October. According to an extract from the 1928 Report of the Commissioner of Fisheries,† twenty-three fish reduction plants on the West Coast of Vancouver Island produced 4,035,879 gallons (about 16,580 tons) of oil and 15,280 tons of meal that year, and of this quantity of oil the bulk was from the pilchard. The corresponding totals for 1929 were approximately 3,000,000 gallons (about 12,420 tons) and 19,500 tons.

Industrial Waste Eliminators, Ltd., of London, have devised plant for use both on land and on trawlers for production of fish meal and for recovery of fish oil, particularly from waste fish and fish refuse. The main features of the equipment are a dryer and concentrator (see Fig. below)—a jacketed machine suitably stayed for a working steam pressure of 80 lbs. per sq. in., fitted with a horizontally placed central shaft operated by bevel gear, carrying suitable beater arms. This works in conjunction with a turbine-centrifugal oil and water extractor, where the oil and surplus moisture are first extracted from the fish. It is the solid residue from this plant that is treated in the drier or concentrator, resulting in the production of a high grade meal which is finally ground to the desired degree of fineness in an "Iwel" disintegrator and grinder.

In this country an improved method for the production of fish meal was devised a few years ago by Messrs. Rose, Downs and Thompson, Ltd., of Hull, and several of their 25-ton continuous fish drying machines have been erected and are in use at the factory of the Hull Fish Meal and Oil Co., Ltd. A feature contributing to the success of this latter company has been the recognition of the fact that fish waste must arrive at the factory in a pure and sweet condition, and to achieve this the fullest co-operation between practically every trawler owner, fish curer, and merchant engaged in the fishing industry in Hull



Drier and Concentrator.

* *J. Soc. Chem. Ind.*, 1928, xlvii., p. 1330.

† Prov. of British Columbia, Fisheries Dept.: *Edible Fish Meal*, 1930, p. 71.

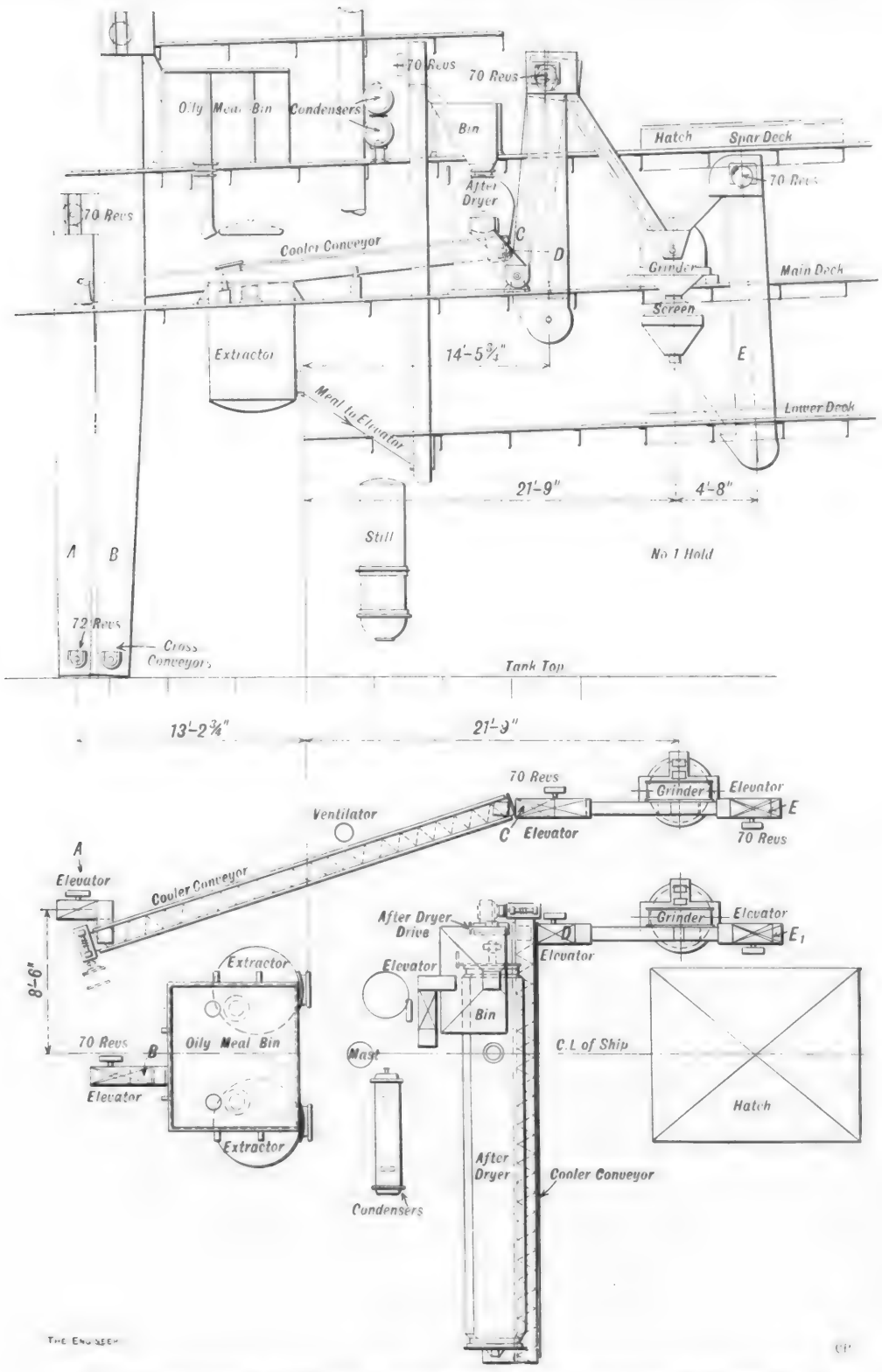


FIG. 1.—Arrangement of Grinding, Drying, and Conveying Machinery in Factory Ship.

on the one hand, and the factory on the other, has been accomplished by making all these interests shareholders in the company as well as suppliers of the raw material.* The wet fish unsuitable for human consumption, together with unsaleable fish and fish refuse, is taken to the factory within a few hours of the arrival of trawlers in port, and by means of mechanical elevators the fish is delivered to fish

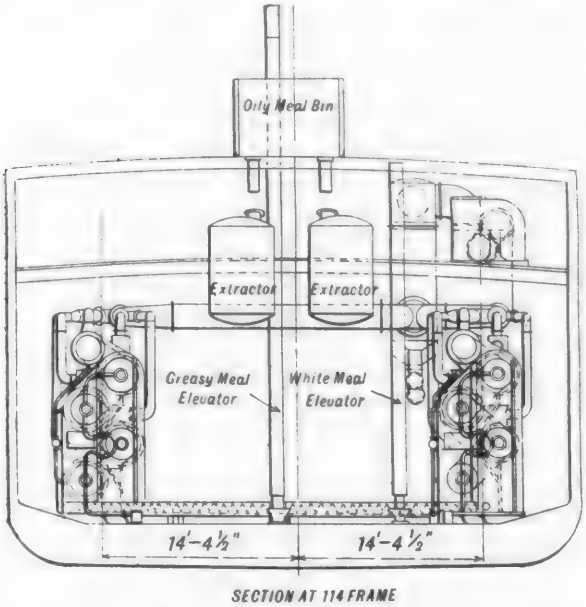


FIG. 2.—Cross Section of Factory Ship showing Disposition of Extractors in Relation to Drying Plant.

hackers where it is crushed. Thence by gravity conveyors it reaches drying machines, the first portion of each of which is a "steriliser" or "coagulator." This steriliser is a circular jacketed vessel through which the crushed fish is conveyed; albumen is coagulated and the fish completely sterilised by means of the low-pressure steam in the jacket. The sterilised material is delivered automatically into the steam-jacketed dryer and thence through a series of steam-jacketed drying drums, and thence delivered in the form of dry meal to the elevators. The whole operation is continuous, and very efficient means are provided for dealing with the vapours emitted. Only about two and a half hours are taken in the drying process. Such non-oily fish as the cod (after removal of the liver), hake, plaice, skate, catfish, haddock, yield a white meal, which is more sought after than the oily meal which results when oily fish such as herring are treated. Meal from the latter is freed from oil, after the completion of the drying, by one of the modern forms of solvent extraction.

The company dealt with over 26,000 tons of fish and fish offal in 1923; since that year the growth has been continuous, and in 1927 about 37,000 tons were treated. By the provision of new plant further progress has been achieved, and in March and April of 1930 as much as 14,500 tons of fish offal were dealt with. These figures are but an indication of the great growth which has taken place in the production of fish meal in the post-war years, and this increase follows on the successful results which have followed researches and feeding experiments in many countries on the use of edible fish meal for cattle, pigs, sheep, and domestic poultry. The richness of fish meal in proteins, in calcium, phosphorus, potassium, and other mineral matters, added to the good keeping qualities of the meal, have ensured its value as a feeding-stuff. The production in the U.K. probably approaches 100,000 tons per annum. In Norway the production is of the same order. Germany alone consumed in 1928 approximately 100,000 tons, 90 per cent. of which was imported: yet in 1923 Germany imported but 6,302 tons. The U.K., Netherlands, Japan, and U.S.A. are likewise large consuming countries.

* *The Fishing News*, May 31, 1930.

Floating Factories.

It is a matter of common knowledge that the production of whale oil under present-day conditions is by operations carried out on the floating factories which accompany the whalers, such factories being furnished with the most modern equipment for the purpose, whereby the blubber is stripped clean from the flesh of the whale, minced and carried by elevators to steam-jacketed kettles, in which it is rendered until the oil separates from the tissues. The development of the floating factory principle has now been carried into the fish oil and fish meal industry, and it is possible to give some particulars of such development in the case of the s.s. *Seapro*. The writer is much indebted to Messrs. Rose, Downs and Thompson, Ltd., of Hull, for the details of the equipment and for permission to reproduce here photographs of the actual plant designed and constructed for the purpose. Figs. 1 and 2 show the general lay-out of this plant.

Fish of all kinds are caught in the waters of South-West Africa, where the s.s. *Seapro* will operate,

FIG. 3.—Fish Hacking Machine and Vapour Exhausting Fan.

and a fleet of motor-boats will do the actual fishing, and these boats, it is hoped, will bring to the floating factory 60 to 100 tons of fish every twenty-four hours. The coarser sorts of fish, whether of the "white" or "oily" variety, fit only for conversion into cattle, pig, and poultry food or for extraction of their oil,

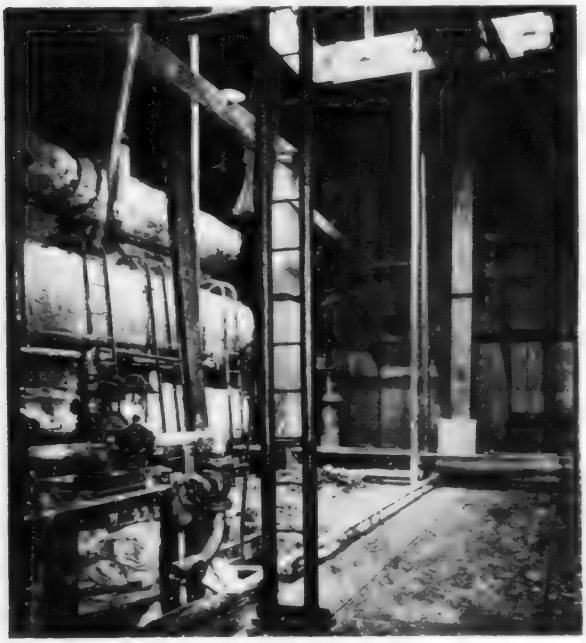


FIG. 4.—Fish Meal Drying Machines surmounted by Sterilising Chambers, with Cross Conveyors and Elevators.

are conveyed down shoots into hacking machines (Fig. 3), one on each side of the ship. These machines consist of two pairs of rolls built up of toothed plates, and the rolls, driven by 15 h.p. motors, rotate at slightly different speeds and so tear up the fish. The material now passes through a 22-ft. sterilising chamber and thence to the drying machine, there being two of these combined chambers and drying machines, as shown in Fig. 4. In this manner albumen is coagulated and harmful bacteria destroyed by the temperature of the steam employed. The drying is effected in four parallel cylinders (Figs. 2 and 4) 44 ft. × 3 ft. and steam-jacketed. Twenty-five h.p. motors are required to drive each of these machines and the cross conveyors. The speed of the conveyor shafts is about 9 revs. per min., and a period of two and a half hours is occupied in passing the fish through the machine. An elaborate system of vapour mains leads away the large quantities of steam produced and the offensive vapours. At the discharge end of the driers are screw conveyors (Fig. 1) into which the dried fish meal can be discharged, and these conveyors deliver the meal to the feet of elevators A and B (Fig. 1). The provision of two elevators is rendered necessary as both white and oily fish may be undergoing drying simultaneously; both conveyors are accordingly arranged to work in co-operation with either elevator or either drier.

Taking white meal, elevator A delivers this ultimately to a grinding and separating machine (Fig. 5), from which finely ground white meal is delivered automatically to bags. Oily fish meal by means of elevator B passes to oil extractors, each of which holds two tons of fish meal, where hot solvent extraction removes oil (Fig. 6), which is freed from solvent in a solvent-recovery still. After removal of oil from meal and the solvent has been drained away, live steam admitted to the extractors vaporises the residual solvent in the meal. Meal discharged from the extractors is now delivered to after driers (Fig. 7), and thence by the cooling conveyor to the grinding and separating plant as used in the case of the white meal.*

A solvent extraction plant for the treatment of certain oily fish meals and for extracting oil from fish having a low oil content has been designed and patented by Messrs. George Scott and Sons, Ltd., of London, and has been described with illustrations elsewhere by the present author.† In broad feature this plant consists of one, two, three, or four percolating tubes mounted above a percolating valve, which in its turn surmounts the dome of the solvent recovery vessel. The upper member of the valve is perforated and is fitted with a suitable mat, the lower member being solid; when the valve is screwed into its proper position, the lower solid member of the valve completely isolates the solvent recovery vessel from tube surmounting it. In this way it becomes possible to have a charge under extraction in the percolating tube, whilst in the solvent recovery vessel below a further charge of raw material may be in process of having the solvent recovered therefrom. The maintenance of high vacuum, coupled with the use of a petroleum spirit of 90-110° C. boiling range, render possible the complete elimination of solvent from the extracted meal. Steam pressure of 80 lbs. per sq. in. is employed, and as this is dry no discoloration of the meal results, nor are the feeding qualities of the meal in any way affected.

* *The Engineer*, April 11, 1930.
† *J. Soc. Chem. Ind.*, 1928, xlvii., p. 1343.

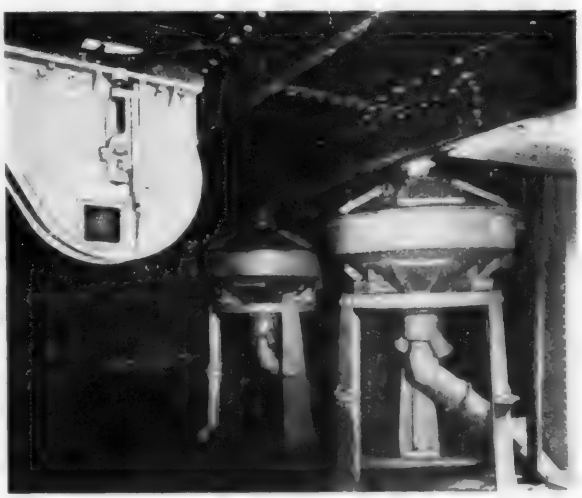


FIG. 5. Separators below the Meal Grinders.

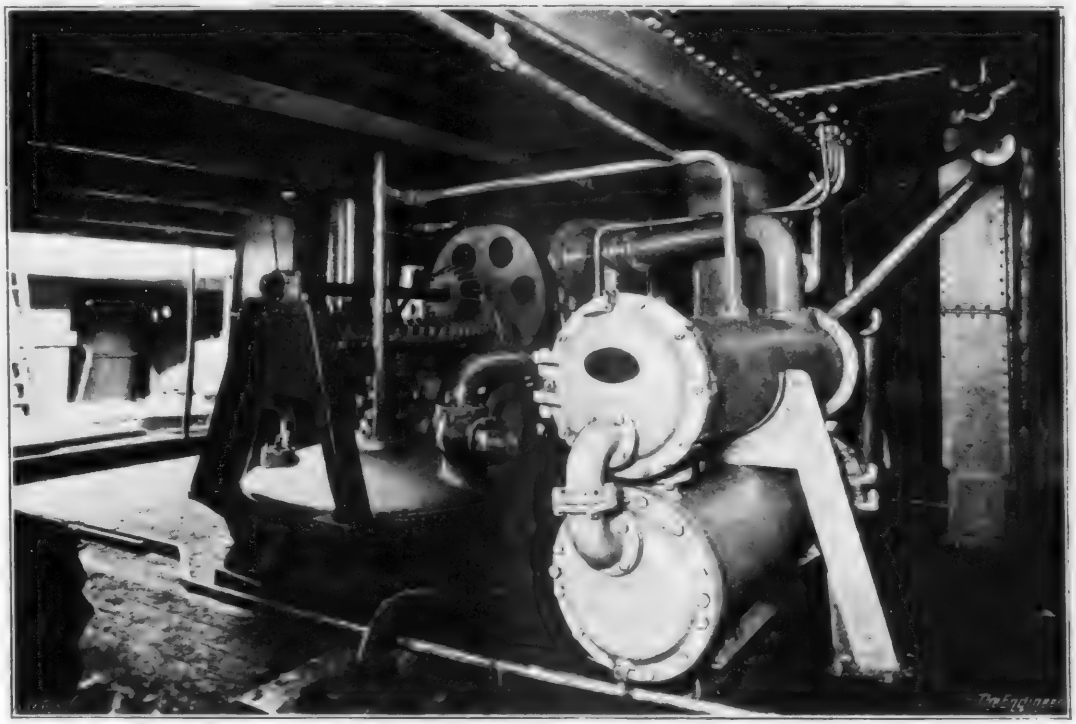


FIG. 6.—Condensers and Top Gear of Extractor Vessels.

FIG. 7.—White Meal Cooling Conveyors and After Driers.

Cold Storage and Canning

The following is a summary of a communication concerning recent practical developments representing the outcome of work carried out at the Low Temperature Research Station, Cambridge.

PART I.—PEAS

THE PRIMARY object of experiments by Morris on the cold storage of peas was to prolong the pea-canning season. The variety with which he worked was Laxton's Superb. The experiments may be divided into two classes:

1. Those in which the peas were held at temperatures just above freezing point—viz., at 1° C. or 34° F.

2. Those in which the peas were actually frozen.

In the first set of experiments, peas were stored as follows:

(*a*) Shelled and stored in a shallow wooden tray in a layer about 3 in. deep. The tray was loosely covered by placing a board on top of it to prevent excessive loss of moisture, as the humidity of the chamber was about 80 per cent. saturated, and the air was kept in motion by a fan. These peas were canned at fairly regular intervals over a period of five weeks.

No mould was seen on the peas under these conditions, but some loss of colour began to be noticed after about three weeks and progressed slowly from that time—*i.e.*, some of the peas began to turn yellow.

There was no noticeable loss of flavour after a month's storage, and on canning at the end of the month they still absorbed the artifical pea colour. After five weeks they began to taste rather old and a little musty, and the skins had toughened slightly.

(*b*) *Peas in Pods.*—These were divided into two lots in shallow trays. One lot was covered to prevent evaporation and the other was left exposed.

The first lot was satisfactory for a month; the peas were rather better than the shelled ones and the pods were still crisp. In the second lot the pods wilted badly after about a fortnight, and probably could not have been shelled by machinery, although the peas themselves were in good condition.

It appears, therefore, that a store which can be kept just above freezing temperature could, if large enough, prolong the pea-canning season for about a month, whether the peas are shelled or not, provided that reasonable care is taken that the atmosphere does not become too dry or too moist. In any case it should be very useful to have such a store to take care of peas during the height of the season and in very hot weather, when they are liable to wilt or heat up quickly. Under such conditions bacteria multiply rapidly and the peas become difficult to sterilise, besides deteriorating in quality.

The second lot of experiments was carried out on the freezing of peas. Naturally, a cold store which will freeze fruits or vegetables solid is more expensive to erect and more expensive to run than one which can only be described as a cool store. It should be remembered, however, that it is impossible to store any foodstuff indefinitely at temperatures above freezing, since the development of moulds and bacteria under these conditions is only a matter of time. For storage over prolonged periods freezing is necessary.

The same variety of peas as before was, therefore, divided into three main lots:

1. Shelled and frozen in tins with no covering liquid.

2. Shelled and frozen in tins with a covering liquid, containing 2 per cent. salt and 2 per cent. sugar.

3. Shelled, blanched seven or eight minutes in boiling water, washed well with cold water, covered with a solution containing 2 per cent. of salt and 2 per cent. of sugar and frozen in tins.

The tins were sealed, but this is not an essential point, as was shown by check lots, which were left open.

Each lot was further subdivided into:

Peas frozen at	−20° C.	and stored at	−5° C.
,,	,,	,,	−20° C.	,,	,,	,,	−10° C.
,,	,,	,,	−20° C.	,,	,,	,,	−20° C.
,,	,,	,,	−10° C.	,,	,,	,,	−10° C.

The net result of these experiments was to indicate that all the *raw* samples, no matter at what temperature they were frozen and stored, or whether covered with liquid or not, developed an unpleasant flavour and smell after being thawed and cooked. Those at the lower temperatures were certainly not so bad as those at −5° C., but the bad flavour was unmistakably there, even after a month's storage, and it can be stated definitely that *peas frozen raw are not satisfactory.* Whether quicker freezing than they were given would be more satisfactory is not known, but there seems little or no point in this in view of the good results obtained after blanching (see below).

As regards the blanched samples, the story is quite different. These were all *quite good* after three months' storage. After four months those stored at −5° C. had gone off a little, and after six months they had gone off still more and had developed some mould, but those at −20° C. and −10° C., *even those frozen and stored at* −10° C.—*i.e.*, 14° F.—*were quite good*, although, perhaps, those at −10° C. were not quite so good as those stored at −20° C. There was no very distinct difference between them. They were excellent when thawed and cooked in the ordinary way and also when canned, and they have absorbed the artificial colour satisfactorily. It is necessary to thaw them—this can be done quite rapidly by immersng the containing vessels in hot water—and to drain off the covering liquor which must be heated up for use as a syrup in canning, otherwise a good deal of flavour will be lost. Freezing blanched peas without a covering liquid has not been tried, but it is quite likely that this would be succcessful also, although it might add to the difficulty of handling them and cause them to break up more.

There are, therefore, two possibilities in storing peas:

1. Storage of shelled peas or peas in pods at 34° F. for about a month.

2. Storage of blanched or partly cooked peas indefinitely at 14° F. or lower.

With regard to vessels in which to freeze the peas, it seems that these should be of metal and strong, so that they can be used over and over again. Probably tinned iron, aluminium, or stainless iron would be satisfactory, and the shape should probably be something lke the ordinary ice-pail for making blocks of ice. Some, however, may prefer freezing on a conveyor or some similar arrangement.

As to the costs of freezing, no data could be submitted; these depend so much on the scale of operations, and the type and size of plant and building put up.

Quite apart from canning, the method offers great possibilities for anyone who would pack and sell peas in friction-top tins in the frozen condition.

PART II.—STRAWBERRIES

With regard to the cold storage of strawberries or other fruits used for canning.

Again the cool store can be used at 34° F. to hold the fruit in good condition (it should be quite fresh and not too ripe) until it can be dealt with or it can be frozen. As was pointed out by Morris at Leicester, strawberries when fresh will keep fit at 34° F. for anything up to a fortnight; some were actually kept in a chip basket for nineteen days, but this is rather exceptional. The average would be nearer a week than a fortnight, unless the fruit is quite freshly picked. One cannot get the fruit out of the cold store in better condition than it is when it goes in, as some people seem to expect. There is no doubt, however, that a cool store can be very useful indeed to a canner. There is also the question of the cool storage of the cans themselves. Morris believes that this would be well worth considering, especially for red fruits. Some varieties of strawberries and cherries have very fine natural colours—the syrup of canned white cherries, even, has a beautiful magenta tint, which is soon lost even in double

lacquered cans at ordinary temperatures, but remains for a much longer period in cool storage.

With regard to the freezing of strawberries. It is convenient to do this either with the addition of half their weight of dry sugar or in syrup of canning strength. In the first case—*i.e.*, when using dry sugar—this must be well mixed with the strawberries and allowed to stand in contact with them at ordinary temperatures with occasional stirring until it has dissolved in the juice drawn from the fruit, after which the whole is frozen. In stirring the fruit to bring the sugar into solution it is, of course, necessary to be careful that it is not jammed and broken. With syrup the procedure is simpler. The fruit is merely covered with the proper quantity of syrup of canning strength and frozen. A third alternative is to half-cook the fruit in syrup of canning strength, adjust the strength of the syrup to make up for loss by evaporation, cool, and then freeze. The cooking should be carried out in closed vessels to prevent loss of flavour, etc. This method should be useful for fruits which, like peas, tend to develop unpleasant flavours or go brown on storage. It does not appear to be necessary for strawberries, but experiments with certain varieties of cherries indicate that some treatment of this sort may be advisable. It certainly has an advantage in that it raises the temperature at which fruits can be held in store. For instance, strawberries treated in this way can be held much better at −5° C. than raw strawberries.

Of course, freezing in sugar or syrup or cooking and freezing shrinks the fruit and alters the weight required per can. Also if dry sugar is used some adjustment is needed in the syrup after thawing. On the whole, it seems simpler to use syrup of canning strength. Theoretically it would seem advisable to freeze in metal vessels—say, aluminium, which could be used over and over again—not too large and shaped so as to handle easily and freeze fairly quickly. Barrels have been used and quite nice samples of fruit frozen in waxed barrels have been obtained, but it must be remembered that wood is a poor conductor, and the shape does not lend itself to quick freezing or quick thawing.

On the whole, with strawberries frozen raw with sugar or syrup, Morris got the best results by freezing and storing at −20° C. (=4° F.); −10° C. (=14° F.) is good but not quite so good as −20° C.; −5° C. (=23° F.) is too high for prolonged storage. It appears, therefore, that for storage in this way the temperature should be below 14° F.—say, 14° F. or under—rather than above it, which means having a very efficiently insulated and well-managed cold store with a plant of considerable capacity.

Again, as in the case of peas, the fruit preserved in this way should have an excellent sale if delivered straight to customers in suitable containers. It is very good indeed and might be a very useful sideline to help in paying the overhead charges on the store. It has been stated that frozen pack fruit is likely to supersede canned fruit. Of course, no one can say what might happen if the public got a taste for the frozen stuff, but it seems that there should be a place for both products, and, *seeing the general advantage of a cold store to the canner,* it might well be worth his while to have a good cold store while he is about it and cater for both trades.

Enquiries

Enquiries are dealt with immediately on receipt, and the desired information is communicated in full by private letter. The replies given below are merely brief abstracts or indications that the names and addresses, or whatever may have been requested, have been supplied. Any further information supplied to us relating to the questions appearing below will be passed on to the enquirers.

193. *Required the names of firms making machines for shredding fats, suet, and the like.* (London.)

The names and addresses of suitable firms were supplied.

194. *I have been referred to your journal for practical information as regards the making and bottling of potted meats for commercial purposes—also for literature on the subject.* (Lincoln.)

Information supplied—so far as it is possible by correspondence. The literature is scanty and unsatisfactory. There is, for instance, Finney's *Handy Guide for Pork Butchers,* but this does not deal with up-to-date factory practice. There are one or two American books which give useful information—particularly *A Complete Course in Canning.*

195. *We would be very interested to learn whether it is perfectly satisfactory to pack meats in solution-ended tins, when they require to be sent to countries at the other side of the Equator, and are wondering if you can give us any authentic information on this subject.* (Edinburgh.)

Up to 2-lb. meat cans it is safe to use solution; beyond 2 lb. solder must be used. For anything above 2 lb. you cannot run the risk of rubber solutions; the strains during processing are such as to destroy the joint, with the possibility of becoming leakers. Messrs. Dewey and Almy, Ltd., of London, recommend confining lining compound for meat packs to 2-lb. sizes. No compound or seam dope ever adds to the mechanical strength of the container, and when these containers are subject to severe strains there is always the danger of the seams being slightly opened in the retorts and destroying the seal. For unprocessed meat packs Dewey and Almy's Gold Seal Oil Proof Lining Compound is perfectly suitable, but for the processed packs there is a special compound known as Gold Seal Lining Compound No. 25, which has been, and is being, very largely used in America for this purpose.

196. *Will you kindly furnish us with the name and address of the British agents for the "Hy-Speed Portable Electric Mixer."* (London.)

The required information supplied.

197. *In the "Food Industries Manual," 1931, you give a list of various publications, including those dealing with preserves, both for home and factory use. What books deal with large-scale manufacture of jam, fruit bottling, fruit preserving in SO_2, and the making of piping jelly, lemon curd, and mincemeat?* (Hereford.)

There are no modern books dealing exclusively with large-scale practice, except those by Cruess and Campbell relating to American practice. There are several in which sections are devoted to domestic procedure. Particulars were supplied. Also references to articles in Food Manufacture. Articles on piping jelly and lemon curd will be published in next month's Food Manufacture.

198. *I was very interested in the article regarding the conservation of various products by the use of moisture-proof cellophane in this month's* Food Manufacture. *I am trying to find a way of putting up dried milk in moisture-proof cartons, and should be glad if you could suggest any way of doing this.* (North Devon.)

We would suggest trying a waxed paper or good vegetable parchment. One would imagine that most firms engaged in large-scale production of waxed cartons build their own plant for waxing. It usually consists of quite a simple arrangement—for example, rows of upright fingers attached to a travelling chain conveyor, a carton being inverted over each finger. The conveyor in the course of its travel dips into a trough of molten wax and then into cold water. In the case of batch work for small or intermittent production, simple hand-dipping or tray-dipping may be resorted to.

199. *Having noticed in an issue of your splendid journal a formula for lemonade crystals in which was used a substance "Cerelose" as a free running agent, I beg further information regarding this product.* (Canada.)

"Cerelose" is the trade name given to dextrose. It has recently been introduced into the confectionery industry, firstly in America and now in England, for general use in candy manufacture. It is made from maize starch by conversion with acid and subsequent re-crystallisation. It is not so sweet as sucrose, and, moreover, forms a super-saturated solution which is more difficult to re-crystallise unless "seeded"—viz., the addition of solid crystals to encourage crystallisation. When allowed to crystallise out slowly, it forms hard, worty crystals, giving the candy a roughness which in some types is desirable. By replacing some of the sucrose sugar by cerelose many pleasing variations can be made in candy. It has many possibilities, and its use in the industry, although not general as yet, may be extended when experiments on its possible uses have been carried out.

For further information on this product we would advise you to get into touch with the Corn Products Co., Ltd., of London, or the Corn Products Refining Co., of New York.

200. *We shall be more than obliged if you will kindly get us in touch with the manufacturers of the "P.R. Breakfast Food," whose address is unknown to us.* (Malta.)

This was done.

201. *We have for disposal almost every day small quantities of bread which is in quite good condition, and yet through some slight fault in appearance, due to rough handling or because it is slightly under-weight, or over-weight, it cannot be sold through the ordinary trade channels. The writer is a regular reader of your journal, and he wondered whether you could put us in touch with anybody who could use this surplus, or if you could suggest to us any use to which it could be profitably put.* (Sheffield.)

Suggested its use as a filler for sausage. We shall be pleased to put any reader interested in the above in touch with the enquirer.

202. *I should be glad if you could inform me of a firm supplying dried spinach (vegetable). What percentage of iron would it contain?* (Devon.)

Names of firms supplied. The iron content of various vegetables was fully dealt with by Peterson and Elvehjem in an article which they contributed to the *Journal of Biological Chemistry*, 1928, page 215. In the various tables included in their article they give the following particulars relating to spinach, parsley, and watercress. You will see that dried spinach would contain—assuming that practically all the water had been driven off—about ·03 per cent. of iron.

Spinach ...	82	per cent. water,	·0066	per cent. iron
Parsley ...	87·6	,, ,,	·01921	,, ,,
Watercress ...	92·5	,, ,,	·00721	,, ,,

203. *We have received an official enquiry as to the possibility of finding a market in the United Kingdom for supplies of wine vinegar from Cyprus. In this connection I shall be much obliged if you will kindly furnish the names of any firms likely to be interested in such supplies, and should also be glad to receive any information regarding the use of wine vinegar in this country.* (London.)

Practically all the vinegar used here is malt vinegar; there is only a relatively very limited sale for wine vinegar, and, apparently, only then for condiment purposes. The supply is mainly drawn from France and is prepared from grape-juice and wines which have become sour; for the best quality, white wine is used. Several firms put up wine vinegar in bottles for table purposes. Tarragon vinegar is made by steeping the herb tarragon (*Artemisia dracunculus*) in white wine vinegar, and the latter is also used, together with olive oil, aromatic flavourings, etc., in the preparation of French mustard and other special mustards.

True wine vinegar must not be confused with the wrongly described "white wine vinegar" distilled from malt vinegar and largely used in Scotland, or with distilled wine vinegar, which is made by some of the British manufacturers.

The enquirer was referred to the chief pickle and sauce manufacturers (names and addresses submitted), to Messrs. Escoffier, Ltd., and to Dr. C. Ainsworth Mitchell, F.I.C., for further information.

204. *Required names and addresses of firms prepared to supply 1 to 2 gal. containers, wooden or otherwise, with a treacle tap, for tomato ketchup.* (London.)

Particulars of firms supplying wooden, steel, and earthenware containers supplied.

205. *I should be much obliged if you would inform me whether the use of certain chemical agents as flour improvers is prohibited in England. I found some interesting technical information in your "Food Industries Manual," 1931, but, although I see that you mention Salox, Ibex, Arkady, Beta Gas, and Agene, I failed to see, on the other hand, which salts or chemicals are not to be used.* (London.)

We understand (although this is not an official statement—which is given below) that there are no regulations prohibiting the addition of any chemical substances to flour as improvers or bleaching agents provided these substances conform to the Food and Drugs Acts as regards arsenic, lead, and dangerous metal contents.

The Departmental Committee, which sat on the subject and issued a Report in 1927, whilst not prohibiting the use of any, were of the opinion that chlorine, nitrogen trichloride (agene), and benzoyl peroxide (novadel) should not be used. The list of substances recommended by the National Association of British and Irish Millers for use as improvers and bleaching agents, and the limits within which they should be used, are:

Extracts of malt and germ	...	No limit
Acid calcium phosphate	...	0·3% or 13½ ozs. per sack
Acid ammonium phosphate	...	0·2% ,, 9 ,, ,, ,,
Persulphates	...	0·04% ,, 1·8 ,, ,, ,,
Chlorine	...	0·07% ,, 3 ,, ,, ,,
Residual nitrites after bleaching with nitrogen peroxide	...	6 parts per million

The following reply was received from the Ministry of Health on this subject:

"In reply to your letter of the 2nd instant on the subject of the use of 'improvers' in flour, I am directed by the Minister of Health to state that there are no regulations specifically prohibiting the use of these substances, but the subject was dealt with in the Report of the Departmental Committee on the Treatment of Flour with Chemical Substances, 1927, in which a synopsis of the legal provisions relating to the sale of bread and flour will be found. Copies of the Report may be obtained through any bookseller or directly from H.M. Stationery Office, Adastral House, Kingsway, W.C. 2, price 6d. nett.

"I am, however, to point out that sections 3 and 6 of the Sale of Food and Drugs Acts, 1875, are superseded by sections 1 and 2 of the Food and Drugs (Adulteration) Act, 1928, the former Act having been repealed.

"With regard to the enquiry of the fourth paragraph of your letter, I am to state that the principal legal provisions relating to the composition and description of food are indicated in the enclosed memorandum (Memo. 36/Foods, January, 1929, Ministry of Health)."

206. *Name of firm required making machinery for the manufacture of "Post Toasties."* (London.)

207. *We are shortly commencing the manufacture of sauces, and are seeking information regarding formulæ for making thick and thin brown sauces. Can you give us any references or assist us in any way? We are, of course, making every possible use of advertisements in* FOOD MANUFACTURE *in the way of obtaining plant, etc., but our information regarding formulæ is not as complete as we should like it to be.* (Bradford.)

Several working formulæ for sauces were supplied (free of cost) to this enquirer.

208. *I should be grateful if you could let me know the name of a firm of jam makers or bottlers who could pack guava jelly in small sample jars. The jelly would be supplied in tins, and the packers would have to undertake the whole operation of bottling and packing in cases.* (London.)

Suitable recommendations were made.

209. *Advice sought regarding books dealing with the manufacture of jams and marmalade.* (London.)

Particulars of such as are available were given.

210. *We should be very glad if you could let us know whether there is any standard for chicken and ham paste or roll.* (Birmingham.)

So far as we are aware, there is no definite legal order on this subject. Of course, by ordinary law, if a substance is sold under the specific title such as this—"Chicken and Ham Paste or Roll," it must consist of the constituents named, otherwise, of course, the vendor would be liable for selling an article not of the nature and substance demanded. The usual regulations on the subject of preservatives apply here.

211. *Can you recommend a book dealing with the making of potted meats and sterilising the same for keeping for long periods in sealed jars?* (Lincoln.)

There is no satisfactory book entirely devoted to this subject. Accordingly, we supplied suggested recipes and some particulars of sterilisation, etc.

212. *We shall be pleased if you could put us in communication with firms manufacturing artificial sausage casings.* (Glasgow.)

So far as we know, the Cellophane Company, Ltd., is the only firm doing this.

213. *In* FOOD MANUFACTURE *of January, 1931, we read on page 13 about new kinds of lacquer for tins, resistant to sulphur. We are interested in this and would be glad of further particulars.* (Holland.)

The enquirer was referred to Arthur Holden and Sons, Ltd., of Birmingham.

214. *We have an enquiry for a plant for sulphur bleaching of walnuts, and we shall be glad if you can put us in touch with a likely source of supply.* (London.)

Below we submit some particulars of plant used for this purpose in connection with fruits; no doubt it would be equally applicable to walnuts. As engineers you will readily design and construct a suitable plant for the purpose. Sulphuring (or bleacher) plant is used in California, etc., for pears, peaches, and apricots, after they have been gathered, cut, and placed on trays, and previous to drying for the preparation of dried fruits. The usual type of plant is simply a wooden, brick, or concrete chamber a few inches longer and wider than the trays, and high enough to take a truck loaded with twenty to twenty-five trays. There should be an adjustable ventilator in the roof. It is a good plan to locate the pit near the end wall of the chamber and to provide a small door for convenience in lighting the sulphur. Sulphur is placed in a small pit in the floor and then burned. The usual time of burning is three to six hours

Another form of bleacher consists of a light wooden frame covered with an airtight fabric, which is simply placed over a stack of trays in the drying yard.

215. *We desire to get into communication with some firm specialising in the porcelain lining or glass lining of steel welded vessels, such vessels being supplied by us.* (Bury.)

A number of firms were suggested who might undertake this work.

216. *We wish to get into touch with some firm having for disposal surplus aluminium, earthenware, slate, or glass-lined vessels.* (Bury.)

We suggested circularising the firms named in our letter.

217. *In a recent issue of* FOOD MANUFACTURE *you have an article on transparent cellulose wrappings. We should be interested to have the name of the manufacturers of transparent cans.* (Hull.)

The addresses of the Hygienic Tube Co. and the Macolite Container Corporation were supplied.

218. *We shall be glad if you will kindly give us information as to whether any firm in the British Isles packs a honey jelly.* (Middlesex.)

We have got into touch with the various honey jelly importers in London, and they inform us that they know of no firm packing honey jelly of this nature.

In point of fact, a full description of the method of making honey jelly was given in the September issue of FOOD MANUFACTURE, *and we suggest that if you have not already seen this article it would be worth while reading it.*

We think the best we can do is to put you in touch with the California Fruit Growers' Exchange, Ltd., of London.

219. *Recipes and instructions required for making piping jelly.* (London.)

See next month's issue of FOOD MANUFACTURE.

220. *Wanted a caramel to prevent the darkening of onions in pickle.* (Durban, South Africa.)

Note.—We wish to make a correction in the reply given last month to Enquiry 174, where it was inadvertently stated that "Another fat-free soya flour is Soyolk." This should read "a starch-free soya flour." It will be remembered that this flour (Soyolk) contains the full 20 per cent. of fat present in the natural bean, that this fat is claimed to remain practically indefinitely free from rancidity (due to treatment by the Berczeller process), and that the flour is a stable article which keeps for months, and possibly for years, under reasonable storage conditions. The special process used is stated to be non-chemical and it extracts certain toxic substances.

Correspondence

LITHOGRAPHED CANS

To the Editor.

DEAR SIR,

I have no désire to enter into a lengthy correspondence on the subject of lithographed cans and processed packs. There are plenty of other people who have had experience in these matters and whose opinion would be of value.

Before replying to Mr. Matthison's letter, I should like to say that my arguments about price and costs are not "purely an assumption." He knows that I bought his firm's lacquer for years in connection with the running of a tin-printing establishment managed by me, though I'd hate to suggest that this necessarily raised costs to a prohibitive level.

It will be good news to most packers that they can get lithographed tins at a price equal to or lower than plain tins, and it certainly is not the experience of large-scale packers that their costs of labelling are high.

There are several large firms whose orders for tins and paper labels run to fifty millions and more of one size at a time. If there is the very slightest advantage either in appearance or price to warrant the use of lithographed tins, it certainly is curious that these firms have all overlooked it.

How does Mr. Matthison propose to deal with a situation like this? Mr. A has a good many acres under peas, and estimates his requirements at two million cans. Mr. B wants about one million. Mr. A gets a spell of bad weather at a critical time, and cannot pack more than three-quarters of his estimate. B, in another district, gets a bumper crop, and requires 20 per cent. more. Each of them has placed his order for printed tins. Is the can maker to hold in stock half a million tins for A and (in the height of his season's rush) deliver two hundred thousand printed tins to B?

Any reasonable person entering a can factory and seeing the manufacture of tins on a large scale, then following them into a cannery and witnessing the operations of exhausting, processing, and handling, will see from the condition of the tin coating that the most amazing care must be exercised at all stages to avoid damage to the outside of the tin. I have yet to see any lithographed processed pack, made on a large scale, that looks so good as a nicely labelled pack.

For unprocessed packs I quite agree that the lithographed container is supreme, though in cautioning packers against the other sort of pack, might I add that I have no axe to grind, and would be just as interested as anyone in finding myself wrong, but Mr. Matthison's letter makes me feel that I am right.

Yours faithfully,
A. A. MAYTHAM.

Trade News

Redler Conveyors.

The engineering department of Messrs. Redler Patents, the manufacturers of the well-known conveyors and bin dischargers, has recently been formed into a separate concern, trading as the Redler Equipment Company of Sharpness, Gloucestershire. A London office has also been opened at Sentinel House, Southampton Row, W.C. 1, under the charge of Mr. Gilbert Bell, M.I.E.E.

* * *

The 1931 Canners' and Allied Trades' Exhibition will be held, in conjunction with the Imperial Fruit Show, at the City Exhibition Hall, Manchester, from October 30 to November 7. Full particulars, including the prospectus and plan, are available on application to the Secretary, Imperial Fruit Show, Ltd., 5, Bloomsbury Square, W.C. 1.

* * *

Unit Speed Reducers.

The "Rapiducer" combined gear and motor unit is described in a leaflet recently issued by the Power Plant Co., Ltd., of West Drayton. The Rapiducer provides in a small space the means of obtaining a low-speed drive from a high-speed electric motor. The power of the electric motor is transmitted through double helical gears, and the result, state the makers, is a unit which provides power economically at the required speed and in a convenient form. The motor is rigidly secured to the gear-casing, perfect alignment being obtained by machined spigot. One objection to the use of individual motor driving is removed by this unit, which renders unnecessary the lining up of a separate gear-box. As supplied, the Rapiducer is complete and ready to set to work by coupling to the driven machine. Efficiency and silence are claimed as a result of the use of accurately generated double helical gears, and roller bearings give rigid support and low-starting resistance. Complete enclosure protects the gears and prevents oil leakage. Rapiducers have been standardised in a series of sizes and transmit from 1 to 100 h.p. They are made in two types—S., which is suitable for a maximum reduction ratio of 6 to 1, and D., which allows a reduction of 25 to 1.

* * *

Whale Oil Difficulties.

It seems, from a statement made at the annual meeting of one of the largest whale oil operators, held in London recently, that whaling companies are now beginning to experience some misgivings as to the future of the industry if the present promiscuous killing of whales is permitted to go unchecked. In explaining why the final dividend of the year was not paid, reference was made to the present low levels at which whale oil is selling in the open market, and it was acknowledged that the recent expansion in production has been too rapid for consumptive requirements. The company was offered opportunities to secure interests in new expeditions, but rejected them, and further announced in the statement that no contract had been yet entered into for the current season's catch of whale oil. Efforts to ensure that future production will keep in line with consumption capacity are now being made.

* * *

Directors of whaling companies met recently at Sandefjad (Norway) to consider the problem of limiting whale oil production. All Norwegian and several foreign companies were represented. It was decided to work out a plan for limiting the production of whale oil to the demands of the markets.

* * *

Applications of Soya Flour.

From time to time new food preparations for which some special dietetic virtues are claimed are introduced to the market, but comparatively few of them succeed in gaining a footing against the competition of the staple foods which have been known and used for centuries. Among these successful few, however, must now be included the flour made by Dr. Berczeller's process from the soya bean. The special properties of this latter are the high fat content (20·6 per cent.) and protein value (44·2 per cent.), while it is capable of being stored for long periods without becoming rancid. Its applications are numerous; the baking trade has found it valuable, as it gives bread the distinctive flavour that ordinary wheat flour lacks, and improves the keeping qualities of the loaf, besides, of course, adding considerably to its nutritive value. In cake making, this soya flour keeps articles moist for a longer time, and economies are effected by the reduced amount of fats, eggs, and milk required. Custards, blancmanges, puddings, biscuits, and egg substitutes are other articles for which this soya flour can be used to improve both the flavour and food value of the goods. In ice-cream it is a valuable constituent, while the high protein content quoted above naturally indicates it for use in vegetarian foods to replace proteins of animal origin, and this consideration, together with the fact that it is practically free from starch, marks it as valuable for diabetic foods.

Invalid and concentrated foods, whether intended for tubercular subjects or not, are suitable for the inclusion of a proportion of the flour, as are also chocolate and cocoa, all kinds of cereal food preparations, and sausages (as a replacement for the bread binder).

* * *

A recent cable from Kingston, Jamaica, states that the stocks of sugar on hand at Jamaica were 7,500 long tons. Domestic consumption during January was estimated at 850 long tons. No sugar was imported, exported, or produced during the month. Final stocks totalled 6,650 long tons.

* * *

No sugar is produced in Persia, so that the import figures represent the consumption for the country. Sugar ranks as the second largest item of import, large quantities being consumed annually in the drinking of tea, which is a beverage constantly found in all private homes, tea houses, and cafés. Russia is by far the largest exporter of sugar to Persia, but large quantities are also sent from Belgium, the Dutch East Indies, and France. During 1929 there were 17,703 long tons of powdered or crystal sugar, and 57,103 long tons of loaf or lump sugar imported into Persia, of which amount Russia supplied by far the greatest share.

* * *

Panama Candy Import Regulations.

A resolution of the President of Panama on August 20, 1930, provides that candy exported to Panama must be precisely declared on Consular invoices and Customs declarations. These must show the class of candy and any other fancy names, establishing clearly the nature and class of the candy, lozenge, or caramel. Any declaration which is not so clear as to leave no doubt about the proper classification will be considered as an attempt to defraud the Customs, the penalty for which is confiscation of goods, double duties, and a fine of 100 to 1,000 balboas (about £20 to £200).

* * *

A decree of the Brazilian Provisional Government provides for an inventory of all stores of Government Departments with a view to the creation of a central purchasing bureau. The British Commercial Secretary at Rio de Janeiro states that if such a reform be subsequently effected, an entirely new complexion may be put upon purchases of public material, and that for this reason he is of opinion that it is of the greatest importance for British firms to be forewarned of the impending change.

Food Industry Stock and Share List

	Mar., 1931.	*Par Value.*	*Feb.*, 1931.
Aerated Bread : Ord. ...	17/3	£1	17/10
6½% Pref.	20/5	£1	21/-
Apollinaris : Ord.	5/0	£1	5/0
Assoc. Biscuit : 6½% Pref. ...	23/3	£1	23/9
Avery (W. and T.) : Ord. ...	43/-	£1	45/-
5% "A" Pref.	4½	£5	4¾
5½% "B" Pref. ...	20/6	£1	20/-
Benger's Food : Ord. ...	29/-	£1	30/6
6% Pref.	4⅞	£5	4⅝
Bovril : Ord.	24/2	£1	24
Deferred	37/-	£1	34/6
6% Pref.	23/3	£1	23/6
4½% Deb.	90	£100	89
British Aluminium : Ord. ...	29/6	£1	29/9
6% Pref.	21/3	£1	21/6
British Thomson Houston :			
7% Pref.	23/9	£1	24/4
Bucknall (H.) and Sons. :			
Ord.	22/-	£5	20/-
Cadbury : 6% Pref.	22/9	£1	23/3
8% 2nd Pref.	28/-	£1	28/6
Callard, Stewart and Watt :			
6% Pref.	17/6	£1	17/-
Carrs : 6½% Pref.	20/4	£1	20/3
Cerebos : Ord.	6⅛	£1	6⅛
Chivers : 6% Deb.	102	£100	102
Cinzano : 7½% Pref. ...	21/-	£1	21/-
Clark's Bread : Ord. ...	22/-	10	21/6
Cow and Gate : 7½% Pref.	22/6	£1	22/10
Criterion Restaurants : Ord.	6/2	5/-	6/9
Crosse and Blackwell : Ord.	1/4	1/-	1/8
7½% Pref.	8/3	15/-	10/6
6½% Deb.	90	£100	93
Dutch Margarine : 5½% Pref.	21/-	£1	20/3
English and Dutch Meat :			
8% Deb.	48	£100	50
Ewart and Son : Ord. ...	15/9	5/-	16/3
16% Pref.	19/-	10/-	19/6
Foster Clark : Ord.	47/6	10/-	50/-
Fry's : 8% "B" Preferred	22/3	£1	22/3
Fullers : Ord.	33/9	£1	33/9
7% Pref.	18/6	£1	18/6
Gordon Hotels : Ord. ...	9/7	£1	9/6
4% Perp. Deb.	68½	£100	72½
Grape Produce :			
8% Ptg. Pf'd. Ord. ...	9d.	5/-	1/-
H.P. Sauce : Ord.	99/6	£1	96/-
Hill (W.) : Ord.	6/-	£1	5/-
Holbrooks : Ord.	14/9	5/-	15/-
5% Pref.	4⅝	£5	4½
Home and Colonial : Ord. .	14/4	4/-	14/10
15% Cum. Ord.	50/-	£1	51/-
6% Cum. Pref.	5¾	£5	5¾
Honywood Hotels : Ord. ...	1/6	2/6	1/4
8% Pref.	14/9	£1	15/3
Hovis : 6% Cum. Pref. ...	23/-	£1	23/3
Imperial Chemical : Ord. ...	15/6	£1	16/7
Deferred	4/-	10/-	4/6
7% Cum. Pref.	20/-	£1	21/4
International Tea : Ord. ...	19/7	5/-	19/8
6% 1st Pref.	23/6	£1	22/6
7% "A" Pref.	25/5	£1	25/6
Jones (R. E.) : Ord.	1/6	5/-	1/9
10% Pref.	8/1	£1	8/-
Jurgens :			
7% Cum. Partg. Pref. ...	23/4	£1	23/6
Kia-Ora : Ord.	7/11	10/-	7/10
Lipton : Ord.	5/-	1/-	4/3
5% 1st Pref.	7¼	10/-	7/6
6% Pref.	8/6	10/-	8/2
6% Deb.	99⅝	£100	98¼

	Mar., 1931.	*Par Value.*	*Feb.*, 1931.
Liebigs : (Reg.)	11½	£5	10⅝
(Bearer)	11½	£5	11
5% Pref.	97/6	£5	99/10
Lovell and Christmas : Ord.	10/-	£1	10/7
Lyons : Ord.	94/5	£1	95/-
"A" Ord.	93/9	£1	94/6
5% Pref.	20/1	£1	21/-
6% Preferred Ord. ...	23/-	£1	23/-
7% Pref.	26/9	£1	27/6
8% Pref.	30/-	£1	31/-
Manbre and Garton : D'f'd.	11/-	2/-	12/3
Mather and Platt : Ord. ...	29/-	£1	35/-
Maypole Dairy :			
20% Preferred	16/6	5/-	16/-
Deferred	4/2	2/-	4/4
5% Pref.	20/-	£1	20/-
Mazawattee Tea : Ord. ...	12/1	6/8	12/-
Meadow Dairy : 7½% Pref.	23/7	£1	23/8
Mellin's Food : 6% Cum. Pref.	3/9	£1	3/9
Molassine : 7% Pref. ...	11/7	15/-	10/6
Nathan (J.) : Ord.	2/3	1/-	2/-
7% Pref.	17/-	£1	16/9
8% Preferred	6/9	10/-	7/6
Nestlés : 8% Pref.	29/10	£1	29/6
Parkinson and Cowan : Pref.	21/-	£1	22/-
Pascall (J.) : 8% Preferred	6/-	£1	8/6
Peak Frean : 5% Pref. ...	19/2	£1	18/2
8% "A" Pref.	25/6	£1	26/3
Radcliffs Edible : Ord. ...	1/3	1/-	2/-
8% Pref.	7/-	10/-	8/6
Radiation : Ord.	32/3	£1	33/6
6% Pref.	22/7	£1	22/6
Rowntree : 7% 2nd Pref. ...	22/6	£1	22/9
Salt Union : Ord.	25/6	£1	29/9
7% Pref.	27/6	£1	30/-
4½% Deb.	82	£100	82
Schweppes : Deferred ...	26/-	£1	30/9
4% Deb.	77	£100	78
Scribbans : Ord.	14/3	£1	14/3
Deferred	1/11	1/-	2/-
Slaters and Bodega : Ord. ...	26/-	£1	26/6
6½% 2nd Pref.	21/-	£1	21/3
Smithfield and Argentine Meat :			
7½% Cum. Pref.	16/4	£1	16/6
Smith's Potato Crisps : Ord.	9/2	5/-	9/-
Spiers and Pond : Ord. ...	12/6	10/-	14/6
6½% Pref.	20/9	£1	20/10
5% Deb.	96½	£100	96
Spillers : Ord.	24/-	£1	25/-
6% Pref.	19/-	£1	19/7
Deferred	7/6	£1	8/-
Strand Hotel : Pref'd. Ord.	67/6	£1	67/8
Tate and Lyle : Ord. ...	35/-	£1	36/8
6½% Pref.	24/2	£1	24/6
Trust Houses : Ord. ...	14/-	£1	14/7
Unilever : Ord.	38/3	£1	39/-
7% Preferred	23/9	£1	24/-
Union Cold Storage :			
6% Pref.	20/8	£1	21/-
7% Pref.	22/6	£1	22/9
10% Pref.	28/-	£1	28/3
United Caterers : Ord. ...	9d.	5/-	8d.
United Dairies : Ord. ...	32/3	£1	32/-
6% Pref.	22/-	£1	22/6
United Glass Bottle : Ord. ...	21/-	£1	20/9
Preferred	22/1	£1	22/-
United Molasses : Ord. ...	12/3	£1	12/6
6% Pref.	11/5	£1	11/6
Van den Berghs :			
15% Preferred Ord. ...	10/6	5/-	10/8
Victoria Wine : Ord. ...	6/3	5/-	6/9

New Companies

W. H. ROSE AND COMPANY, LIMITED. (254454.) To take over the bus. of edible oil mchts. cd. on by W. H. Rose and Co. at 2 and 4, Vestry Street, Leicester. Nom. Cap.: £1,000 in £1 shares.

HULL AND HUMBER BACON SMOKING COMPANY, LIMITED. (254395.) To carry on the bus. of produce importers, exporters, smokers, and distributors of bacon, etc. Nom. Cap.: £100 in £1 shares.

BUNGE AND COMPANY, LIMITED. (254319.) To acquire the undertaking, assets, and liabilities of Bunge and Co., Ltd., and to carry on the bus. of grain, india-rubber, produce, and genl. mchts. and commission agents, etc. Nom. Cap.: £1,000,000 in £10 shares.

FIELD'S (PROVISIONS), LIMITED. (254372.) 32, High Street, Ponders End. To carry on the bus. of provision mchts., etc. Nom. Cap.: £500 in £1 shares.

BARTLETT, LIMITED. (254614.) To carry on the bus. of bakers, confectioners, etc. Nom. Cap.: £1,500 in £1 shares.

ELDORADO LAND AND FRUIT COMPANY, LIMITED. (254585.) 41, Threadneedle Street, E.C. 2. To acquire land, or any option or right of purchase or leasing relating thereto, in any part of the world, and to plant and cultivate the same and produce fruit, corn, timber, vegetables, etc.

SOUTHERN STAFF SUPPLY STORES, LIMITED. (254337.) To carry on the bus. of grocers, provision mchts., confectioners. Nom. Cap.: £100 in 90 ord. shares of £1 and 200 pref. of 1s.

HOT MEALS DELIVERY SERVICE, LIMITED. (254414.) To carry on the bus. of caterers, restaurateurs, etc. Nom. Cap.: £100 in 2s. shares. T. Cornelius, 176, Norbury Crescent, S.W. 16.

CHANCE (CATERERS), LIMITED. (254407.) Warple Way, Acton Vale, W. 3. To carry on the bus. of caterers and refreshment contractors, etc., cd. on at Acton, Shepherd's Bush, and elsewhere, as "C. Chance." Nom. Cap.: £15,000 in £1 shares.

LONDON AND NORTH-EASTERN STAFF SUPPLY STORES, LIMITED. (254328.) To carry on the bus. of grocers, provision mchts., confectioners, etc. Nom. Cap.: £100 in 90 ord. shares of £1 and 200 pref. of 1s.

QUALITY FISH RESTAURANT, LIMITED. (254419.) To carry on the bus. of wholesale and retail fish and oyster mchts., etc. Nom. Cap.: £500 in £1 shares.

TWEEDDALES, LIMITED. (253764.) The Minories, 131 to 133, Jesmond Road, Newcastle-upon-Tyne. To take over (1) the bus. of a baker, confectioner, and assembly hall propr. cd. on at Newcastle-upon-Tyne and Gosforth by Mrs. E. Lockey as "Tweeddales," and (2) the bus. of a baker and confectioner cd. on at 90 to 92, Raby Street, Newcastle-on-Tyne, by J. Melville. Nom. Cap.: £2,000 in £1 shares.

RHOADES ROBERTSHAW, LIMITED. (253762.) Wickin Cragg, Cross Roads, near Keighley. To carry on the bus. of fat refiners and dripping mnfrs., oil extractors, etc. Nom. Cap.: £1,500 in £1 shares. Dirs.: E. Greenwood, 40, Cross Roads, near Keighley; Mrs. E. Robertshaw, 3, Myrtle View, Cross Roads, near Keighley.

SUPERIOR FISH RESTAURANTS, LIMITED. (254423.) To carry on the bus. of wholesale and retail fish and oyster mchts., etc. Nom. Cap.: £500 in £1 shares. Permt. dirs.: J. Porter, 134, Leigh Road, Leigh-on-Sea; E. Porter, 137, Shaftesbury Avenue, Thorpe Bay (permt. mang. dir.); Doris E. Smith, 37, Shaw Road, Blackpool.

TAVOY RUBBER COMPANY, LIMITED. (253121.) 1 and 2, Great Winchester Street, E.C. 2. To acquire an estate in Burma cd. on by Tavoy Rubber Co., Ltd. (in liquidation); to enter into an agmt. with the Amalgamated Finance Company (1929), Ltd.; and to carry on the bus. of cultivators of and dlrs. in rubber, palm oil, coffee, tea, etc. Nom. Cap.: £100 in 1s. shares. Dirs.: Not named. Remun. of dirs.: As voted by the company. Subs.: S. G. Kinnear, 44, Whateley Road, S.E. 22 (clk.); S. J. Sulston, 1, Broad Street Place, E.C. 2 (incorpd. secy.).

AMALGAMATED FARMERS, LIMITED. (253478.) 235, Regent Street, W. 1. To carry on the bus. of producers and mnfrs. of and dlrs. in butter, cheese, milk, groceries, meat, etc. Nom. Cap.: £100 in £1 shares. Dirs.: Not named. Qual. of dirs.: £1. Subs.: H. T. Dowles, 12, Gloucester Road, Romford (clk.); I. Muriel Robertson, 3, Lisburne Road, Hampstead, N.W. (clk.).

EDWIN S. STABLER, LIMITED. (253462.) To take over the bus. of a wholesale and retail grocer, etc., cd. on by E. S. Stabler at High Street, Normanton; to acquire the formula of and all rights to mnfre. and sell the self-raising flour known as "Raido," and the benefit of the trade-mark for same when granted. Nom. Cap.: £1,500 in £1 shares. Permt. dirs.: E. S. Stabler, Hessle House, Altofts, near Normanton; J. MacArthur, 19, Cambridge Street, Normanton; Dorothy S. Stabler, address not stated. Qual. of dirs.: £50 shares.

THOMAS REAVEY, LIMITED. (252731.) 3, York Street, Manchester. To take over the bus. of fish and game dlrs. cd. on at the Wholesale Fish Market, Manchester, as "Thomas Reavey." Nom. Cap.: £250 in £1 shares. Dirs.: Mrs. M. Boylan, Glen Murray, Wilbraham Road, Alexandra Park, Manchester; H. Whitehead, 11, Eccles Road, Swinton, Lancs. Qual. of dirs.: £1.

Lacquer Protection of Fruit and Vegetable Cans

(*Concluded from page* 106).

To overcome this difficulty several ingenious types of lacquer have been invented. In one type of sulphur-resisting lacquer a substance is included which combines with the sulphur gases, producing a colourless compound. Thus the sulphur is chemically combined in the lacquer before it has succeeded in reaching the tinplate. The second class of lacquer used for checking sulphur stain works on a different principle; here the added substance is totally inert, but forms a solid screen through which the gases cannot pass.

The first of these types of lacquer is unsuitable for use with acid substances, and so must not be used with fruits or tomatoes; but it is found to give satisfactory results with certain meats and fish, which normally cause darkening of the tinplate. In the case of heavily drawn cans, such as are used for packing fish, both the tinplate and the lacquer employed must possess a particularly high degree of flexibility. Special lacquers are sometimes used for this class of work.

The above few remarks on the methods of lacquer protection of food containers should indicate that by the judicious selection of a suitable type of lacquer the appearance and quality of canned goods may be very greatly enhanced.

The writer is greatly indebted to Mr. W. A. Clark, F.R.P.S., of Messrs. Arthur Holden and Sons, Ltd., who kindly photographed the strips of plate which form the illustrations to the present article.

Current Literature

Fruit and Vegetable Products

117. Frozen Orange Juice makes its Bow. E. G. Moore. (*Fruit Prods. Journ.*, 1931, February, p. 174.)
118. Preservation of Fruit Specialities. W. V. Cruess and J. H. Irish. (*Ibid.*, p. 177.)
119. Survey of the Preserving Industry for 1929. (*Ibid.*, p. 184.)
120. Standards for Peas, Peaches, and Pears. (*Canner*, 1931, February, p. 11.)
121. Buying Tomatoes on Grade. F. C. Gaylord. (*Ibid.*, p. 17.)
122. Packaging Catsup and Chili Sauce. (*Ibid.*, p. 25.)
123. The Coral Pea as a Source of Fat. E. Castagne and L. Adrians. (*Matieres Grasse*, 1930, December, p. 9032.)
124. Olive Oil Extraction. (*Ibid.*, p. 8980.)
125. Pectin from Lemons. B. Melis. (*Giorn. di Chim. ind. applic.*, 1930, p. 353.)
126. Enzymic Clarification of Cyder. Z. I. Kertesy. (N.Y. State Agric. Exper. Station, 1930, Bulletin No. 589.)
127. Profitable Utilisation of Tomato Pomace. E. D. Stewart. (*Food Ind.*, 1931, March, p. 112.)
128. Insect Control in Dried Fruits. H. M. Reed. (*Ibid.*, p. 117.)
129. Standardised Production of Tomato Juice. R. H. Winters. (*Ibid.*, p. 122.)

Cereal Products

130. Reducing Starch Explosion Hazards. (*Food Ind.*, 1931, February, p. 106.)
131. Odours in Bakery Products. P. G. Pirrie. (*Bakers' Weekly*, 1930, p. 49.)
132. Sugar or Honey in Bread. W. F. Geddes, C. A. Winkler. (*Canadian Journ. of Research*, 1930, December, p. 543.)
133. Cutting Costs in the Cake Bakery. (*Bakers' Weekly*, 1931, January, p. 53.)

Dairy Products

134. Improved Process for Casein. F. L. Chappell. (*Food Ind.*, 1931, March, p. 102.)
135. Determination of the Milk Proteins. G. M. Moir. (*Analyst*, 1931, March, p. 147.)
136. Fatty Acids and Component Glycerides of Indian Ghee. R. Bhattacharya and T. P. Hilditch. (*Ibid.*, p. 161.)

Analysis

137. Analysis and Composition of Vegetable Parchment used for Packing Dairy Products. P. Arup. (*Analyst*, 1931, March, p. 149.)
138. Indications of Glucose in Milk. C. W. Whitnah. (*J. Amer. Chem. Soc.*, 1931, p. 300.)
139. Determination of Starch in Cereal Products. C. W. Herd and D. W. Kent Jones. (*J. Soc. Chem. Ind.*, 1931, 50, p. 15.)
140. Detection of Sorbitol in Jams. C. F. Muttelet. (*Ann. Falsif.*, 1930, p. 602.)
141. Nitrous Acid and the Vitamin B Complex. H. C. Sherman and M. L. Whitsitt. (*J. Biol. Chem.*, 1931, p. 153.)
142. Aspergilli and Decay in Apples. G. A. Huber. (*J. Agric. Res.*, 1930, p. 801.)

Various

143. Production of Satisfactory Caramels. C. Clay. (*Manuf. Conf.*, 1931, March, p. 63.)
144. Selective Irradiation and Vitamin D. B. Hubbell. (*Canner*, 1931, February, p. 7.)
145. Research Survey Reveals Answer to Packing Problems. C. G. Hicks. (*Glass Container*, 1931, February, p. 8.)
146. Refrigerating Plant Hazards. (*Nat. Provisioner*, 1931, February, p. 21.)
147. Chemistry in the Canning Industry. C. W. Stuart. (*Canner*, 1931, March, p. 17.)
148. Choosing Refrigeration Equipment for Quick Frozen Foods. (*Nat. Provisioner*, 1931, March, p. 27.)

Book Reviews

Tinplate Decoration and the Lacquering of Food Containers. By A. Ll. Matthison. (Photographs by Wm. A. Clark, F.R.P.S.) Pp. 121. Plates 66. Birmingham, 1931. Price 12s. 6d.

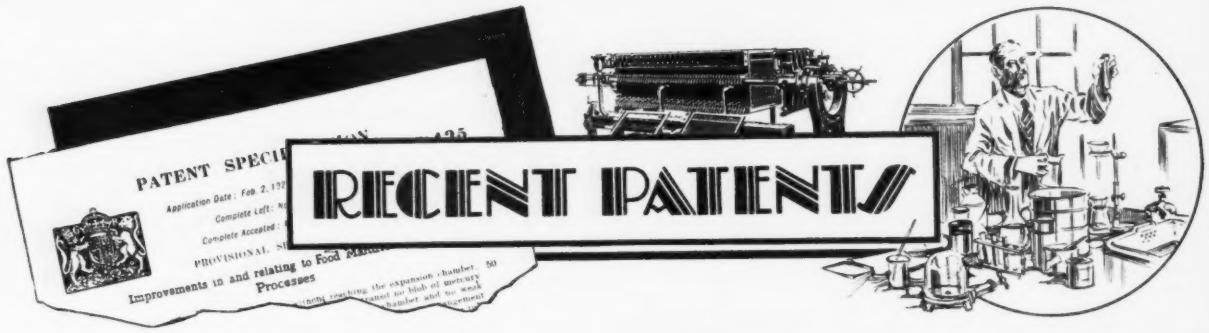
Three years ago the author, who is well known by his literary contributions and technical services to the canning industry on the subject of lacquers, produced a small handbook on *Stoving Finishes for Tinplate Decorators and Tin Box Manufacturers*, which was well received by the trade by reason of the large amount of valuable practical information which it contained. The present volume is the outcome of the successful career of its predecessor and of the numerous requests for a more extended survey of the subject. A glance through the book is sufficient to convince one that the author possesses a happy—but all too rare—combination of enthusiasm, wide experience, technical knowledge, and a broad, well-balanced outlook. Although essentially a practical man, who has during a busy technical and commercial life accumulated unique experience and information in this particular department of lacquering, Mr. Matthison has found time for study and research. We are very pleased with his wide outlook and his appreciation of the bearing of scientific research on practice. Doubtless this is the outcome of his varied experience of factory procedure in America, Canada, and all parts of Europe, and his discussions with all manner of men connected with the practical, technical, commercial, and scientific aspects of the industry. Anyhow, Mr. Matthison has turned out an excellent book, which should certainly be in the hands of everyone concerned with canning or can making. Some of the subjects covered are: Cleaning of tinplate; ovens, their construction, operation, and control; varnishing machines and varnishing; research applied to food containers; the lacquering of cans for foods; cooking and sterilising; cleansing machines and methods; American practice.

Finally, Mr. Clark is to be congratulated on the excellence of the coloured photographs with which the book is profusely illustrated.

The Corrosion of the Tinplate Container by Food Products. By T. N. Morris, M.A., Dip. Ag., and J. M. Bryan, B.Sc., of the Low Temperature Research Station, Cambridge. Department of Scientific and Industrial Research. Food Investigation; Special Report No. 40. London. February, 1931. Pp. 85. Figs. 29. Price 1s. 6d. net, obtainable from H.M. Stationery Office.

Great credit is due to Morris and Bryan and the Low Temperature Research Station at Cambridge for this Report, which represents the results of three years' work on what is generally recognised to be the most fundamental problem of the industry—namely, the corrosion of the tinplate container. Undoubtedly this work will prove to be of great assistance to the industry; personally, we consider it is the most important contribution yet made by organised scientific research to the canning industry. It is conprehensive and thorough; it throws light on underlying causes of corrosion—and that is the only way of tackling the subject effectively.

There is no need here to review the contents of the publication; a brief account of the main results arrived at by Morris and Bryan is given on another page. However, for a proper understanding of the subject, readers should consult the Report.



These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office.

Latest Patent Applications

5201. ALGEMEENE KUNSTZIJDE UNIE NAAMLOOZE VENNOOTSCHAP. : Treating cheeses with liquids. February 18.
4958. PARKINSON, R. H. : Manufacture of preserved foodstuffs, etc. February 17.
5477. YOUNG, A. W. : Food, etc., containers. February 21.
4422. LOCKYER, E. G. F. : Apparatus for keeping food cool. February 12.
3950. FINDLAY, H. C. : Washing and grading coffee, etc. February 7.
6531. BALDWIN, W. : Openers for canned goods. March 3.
6907. BALLARD, F. J. AND CO., LTD. : Cooking and cooling apparatus for fruit in sealed cans. March 5.
6702. PASCALL AND CO., LTD. : Formation of animal, etc., figures in sweetmeats. March 4.
7022. RUTTER, A. : Manufacture of malted milk. March 6.

Specifications Accepted

36883. KELLOGG CO. : Method of producing a cereal food.
5695. HARTMANN, R. : Machine for wrapping sweetmeats and similar articles.
10839. VALE, W. J. H. : Strainer for lemons, oranges, grape fruit, etc.

Complete Specifications Published

2945. EMULSOL CORP. : Method of producing improved emulsions, particularly of margarine.
5922. MEHLITZ, A. : Preparation of fruit juices.

Specifications Published

343,308. SOLLICH, R. : Process and apparatus for manufacturing sugar sweetmeats and the like.
342,778. CLIFTON, W. E. : Manufacture or treatment of coffee.
342,967. GARBUTT, H., and WHITTAKER, A. : Packing of sweetmeats.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2., at the uniform price of 1s. each.

Recent Trade Marks

This list of Trade Marks of interest to readers has been selected from the "Official Trade Marks Journal," and is published by permission of the Controller of H.M. Stationery Office.

VITSU.—517,271. **Suet and lard (for food).** VITSU, LTD., 26, Warwick Row, Coventry. March 4.

SOCODA.—517,620. **Milk, butter, cream, cheese, and tea.** SOUTHERN COUNTIES DAIRIES CO., LTD., 150, North Street, Brighton. March 4. (By Consent.)

HEATHER.—518,103. **Condensed milk and evaporated milk (for food).** THE NEW ZEALAND CO-OPERATIVE DAIRY CO., LTD., Dairy Buildings, corner of London Street and Victoria Street, Hamilton, Auckland, New Zealand. March 4.

BRITTSALTS.—518,482. **Biscuits, sweetmeats, cakes, cereals for use as food, confectionery, and pastry.** DISERENS BROTHERS, 29, Winchester Road, Swiss Cottage, London, N.W. 3. March 4.

LA CHAUMIERE.—518,484. **Preserved fruit, preserved vegetables, and preserved meat,** all sold in tins or in glass or earthenware containers. ERBOS, LTD., 15, Fitzroy Street, London, W. 1. March 4.

LITOXEL.—519,258. **Beef suet, potted beef, sausages, and ox tongues.** WILFRID BAUGH, 3, The Nook, Skegby, near Mansfield, Nottinghamshire. March 4.

GOLD STANDARD. — 517,112. **Sauces, pickles, condiments, mayonnaise, fresh vegetables (for food) and fruits, dried, canned, bottled, and preserved vegetables and fruits, preserved and canned fish, meats and soups, dried herbs (for food), jams, jellies (for food), marmalade, jelly powders (for food), jelly tablets (for food), custard powder, lemonade powder, lemonade crystals, baking powder, blancmange powder, ice-cream powder, egg substitute (for food), coffee essence, lemon curd, mincemeat, honey, dried peel, puddings, and fruit syrups, fruit juices, and fruit crushes (none being alcoholic).** CHIVERS AND SONS, LTD., The Orchard Factory, Cambridge Road, Histon, Cambridge. March 4. (Associated.)

HOLLY HILL.—513,979. **Canned vegetables, canned fruits, canned fish, canned meats.** HOLLY HILL FRUITS PRODUCTS, INCORPORATED, Davenport, Florida, United States of America. February 25.

MESSRS. S. W. SMEDLEY AND CO., LTD., the well-known English fruit and vegetable canners, are running a large advertising campaign in London and Greater London, a feature of which is an ingenious cross-word puzzle, for the solution of which large cash prizes are offered. The retailer who has supplied the successful competitor with the canned peas also receives a handsome prize. The solution to the puzzle has been sealed and lodged with Sir Edgar Jones.

FOOD MANUFACTURE is sent to any address in the World for 10s. per annum. Send your subscription now to LEONARD HILL, LTD., Thanet House, 231-2, Strand, London, W.C. 2.